THE MAHATMA GANDHI UNIVERSITY UNDER GRADUATE VOCATIONAL PROGRAMMES (HONOURS) SYLLABUS

MGU-B.VOC. (Honours)

(2025 Admission Onwards)

Faculty: Science

Expert Committee: Core Industrial and Infrastructure Skills

Programme: B.Voc. (Honours) Renewable Energy management

Mahatma Gandhi University

Priyadarshini Hills
Kottayam – 686560, Kerala, India

Contents

Preface

The **Bachelor of Vocation (B.Voc) in Renewable Energy Management** is a skill-based, industry-oriented undergraduate program designed to equip students with the technical knowledge and practical expertise required in the rapidly growing renewable energy sector. This syllabus has been structured to align with current industry needs, national energy goals, and global sustainability standards.

The curriculum offers a balanced mix of foundational theory, technical training, and hands-on exposure in areas such as solar energy, wind energy, bioenergy, energy efficiency, and environmental management. Alongside technical competencies, the syllabus also emphasizes soft skills, entrepreneurship, and project management to prepare students for diverse roles in the energy sector.

In keeping with the objectives of the National Skill Qualification Framework (NSQF), the syllabus has been developed in collaboration with academic experts and industry professionals to ensure relevance, employability, and practical skill development at every level. The program allows for multiple entry and exit points with appropriate certification, making it flexible and learner-friendly.

This document serves as a comprehensive guide to the course structure, learning outcomes, and subject-wise content for each semester. It is our hope that this syllabus will serve as a roadmap for both students and educators, fostering competence, innovation, and leadership in the field of renewable energy.

Expert Committee & External Experts

1. EXPERT COMMITTEE FOR CORE INDUSTRIAL AND INFRASTRUCTURE SKILLS (6)

1	Dr. Sreeja R (Convenor)	Associate Professor of Physics	Maharaja's College Ernakulam
2	Dr. Laigi Joseph	Associate Professor of Chemistry	T.M.J.M Government College, Manimalakunnu
3	Dr. Jeen Maria Mathews	Assistant Professor of Physics	Newman College, Thodupuzha
4	Dr. Arun Vinod	Assistant Professor of Physics	Mar Thoma College, Thiruvalla
5	Sruthi Soman	B.Voc Nodal Officer	Sree Sankara College, Kalady
6	Minitha Susan Joseph	B.Voc Nodal Officer	St. Albert's College, Ernakulam

Syllabus Index

Name of the Major Subject: Renewable Energy Management

Semester: 1

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week		
					L	P	O
MG1SDCREM100	Electrical fundamentals and Electronics	SDC	4	4	4	0	0
MG1SDCREM101	Fundamentals of renewable energy technology	SDC	4	5	3	2	0
MG1SDCREM102	Mathematics for renewable energy- 1	SDC	4	5	3	2	0
MG1MDCREM100	Renewable energy in daily life	MDC	3	3	3	0	0
MG1SDCREM103	On -the -Job Training	SDC	2	5	0	0	5

L — Lecture, P — Practical/Practicum , O — On the Job Training

Semester: 2

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week		
					L	P	O
MG2SDCREM100	Energy and power fundamentals	SDC	4	4	4	0	0
MG2SDCREM101	Solar photovoltaic systems	SDC	4	5	3	2	0
MG2SDCREM102	Mathematics for Renewable Energy- 2	SDC	4	5	3	2	0
MG2MDCREM100	Energy efficient buildings	MDC	3	4	2	2	0
MG2SDCREM103	On -the -Job Training	SDC	2	5	0	0	5

L — Lecture, P — Practical/Practicum , O — On the Job Training

Semester: 3

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week		
					L	P	O
MG3SDCREM200	Material science for renewable energy technology	SDC	4	4	4	0	0
MG3SDCREM201	Solar thermal technology	SDC	4	5	3	2	0
MG3SDCREM202	Aerodynamics for wind turbine generators	SDC	4	5	3	2	0
MG3MPCREM200	Introduction to solar cells and applications	MPC	4	5	3	2	0
MG3MDCREM200	IKS for renewable energy transformation in Kerala	MDC	3	3	3	0	0
MG3SDCREM203	On - the - Job Training	SDC	2	5	0	0	5

L — Lecture, P — Practical/Practicum , O — On the Job Training

Semester: 4

Course Code	Title of the Course	Type of the Course	Cred it	Hours/ Week	Hour Distribution /week		
					L	P	O
MG4SDCREM200	Sustainable development and climate changes	SDC	4	4	4	0	0
MG4SDCREM201	Hydro power system	SDC	4	5	3	2	0
MG4SDCREM202	Biomass conversion system	SDC	4	5	3	2	0
MG4MPCREM200	Solar Heating and Cooling Techniques	MPC	4	5	3	2	0
MG4SECREM200	Data analytic and computational techniques	SEC	3	3	3	0	0
MG4VACREM200	Environmental education	VAC	3	3	3	0	0
MG4INTREM200	Internship	INT	2	20 days on Sem Break			

L — Lecture, P — Practical/Practicum , O — On the Job Training

Semester: 5

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week		
					L	P	O
MG5SDCREM300	Tidal ,nuclear and geothermal energy systems	SDC	4	4	4	0	0
MG5SDEREM300	Energy storage systems	SDE	4	5	3	2	0
MG5SDEREM301	Green Hydrogen Manufacturing and Applications						
MG5SDCREM301	Grid integration and smart grid technologies	SDC	4	5	3	2	0
MG5MPCREM300	Novel renewable energy sources	MPC	4	4	4	0	0
MG5SECREM300	Soft wares for renewable energy system design	SEC	3	4	2	2	0
MG5VACREM300	Industrial Health and Safety	VAC	3	3	3	0	0

L — Lecture, P — Practical/Practicum , O — On the Job Training

Semester: 6

Course Code	Title of the Course	Type of the Course	Credit	Hours/ week	Hour Distribution /week		
					L	P	O
MG6SDEREM300	Power electronics	SDE	4	5	3	2	0
MG6SDEREM301	Photovoltaic module installation						
MG6SDCREM300	Wind power technology	SDC	4	5	3	2	0
MG6MPCREM300	Energy Management & Auditing	MPC	4	4	4	0	0
MG6SECREM300	Renewable energy policies and business models	SEC	3	3	3	0	0
MG6VACREM300	Energy conservation techniques	VAC	3	3	3	0	0
MG6PRJREM300	Project	PRJ	4	8	0	8	0

L — Lecture, P — Practical/Practicum , O — On the Job Training

B.voc Honours - with Apprenticeship

Semesters: 7 & 8

Course Code	Title of the Course	Type of the Course	Credit	Number of days	Hour Distribution		
					L	P	O
MG7APPREM400	Apprenticeship	APP	28	280	0	0	28
NA	Online	MPC	4	NA	0	0	0
NA	Online	MPC	4	NA	0	0	0
NA	Online	MPC	4	NA	0	0	0

L — Lecture, P — Practical/Practicum , O — On the Job Training

B.voc Honours – with Research Internship

Semesters: 7 & 8

Course Code	Title of the Course	Type of the Course	Credit	Number of days	Hour Distribution		
					L	P	O
MG7RINREM400	Research Internship	RIN	20	200 days	0	0	20
NA	Online	SDC	4	NA	0	0	0
NA	Online	SDC	4	NA	0	0	0
NA	Online	MPC	4	NA	0	0	0
NA	Online	MPC	4	NA	0	0	0
NA	Online	MPC	4	NA	0	0	0

Job Roles and Qualification Packs for Certificate, Diploma, Bachelor's, and Honours Degrees.

JOB ROLES	NHEQF LEVEL	QPs ALIGNED	SECTOR SKILL
Solar PV Installer	4.5	SGJ/Q0101	Skill council for green jobs
Maintenance Supervisor	5.5	SGJ/Q0102 Solar PV Technician	Skill Council for Green Jobs
Maintenance Supervisor	5.5	SGJ/Q0902	Skill Council for Green Jobs

SEMESTER 1

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Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Electrical fundamentals and Electronics</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG1SDCREM100</td></tr>
<tr><td>Course Level</td><td colspan="5">100</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the foundational principles of electrical and electronics. It begins with basic electrical concepts and extends to the analysis of DC and AC circuits using fundamental laws and theorems. The course also explores essential electronic components along with their applications in rectification and amplification.</td></tr>
<tr><td>Semester</td><td>1</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60 hrs</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Recall basic electrical laws, circuit components, and electronic device symbols.	K	1
2	Understand the basic concepts of electric circuits, laws, and network theorems.	U	1, 2
3	Apply fundamental laws to calculate electrical parameters in simple circuits.	A	2, 10
4	Identify and explain the characteristics and working principles of basic electronic devices	U, A	1, 2
5	Design simple rectifier and amplifier circuits using semiconductor devices.	A	1, 10
**** Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	0	0	0	0	0	0	0
CO 2	3	2	0	0	0	0	0	0	0	0
CO 3	0	3	0	0	0	0	0	0	0	1
CO 4	2	2	0	0	0	0	0	0	0	0
CO 5	2	0	0	0	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Electrical measurements and controls 15hrs**			
	1.1	Voltage sources-constant voltage source- constant current sources	3	1
	1.2	Ohm's law- resistors- fixed and variable- colour code- capacitors- inductors	3	1, 2
	1.3	Types of cables- hook-up, coaxial- multicore power and control cable	3	1
	1.4	Switches- slide- toggle- push to on and push to off	3	1
	1.5	Applications of rocker- construction and working of relay	3	1
2	**Varying and alternating current**		**15hrs**	
	2.1	Growth and decay of current through inductor, charging and discharging of capacitor	5	2, 3
	2.2	Alternating current- peak and rms value	4	2, 3
	2.3	LCR circuit- series and parallel- practical applications- Q-factor- power factor	6	2, 3
3	**Network theorems**		**10hrs**	
	3.1	Distribution of three phase current- star connection- delta connection	3	2, 3
	3.2	Thevenin's theorem	2	2, 3
	3.3	Norton's theorem	2	2, 3
	3.4	Maximum power transfer theorem, superposition theorem	3	2, 3

4	**Electronics**		**20hrs**	
	4.1	Atomic structure- electrons- valence electrons- conduction electrons- Classification of materials- metals- insulators- semiconductors	5	4, 5
	4.2	Doping- pn junction- biasing	3	4, 5
	4.3	Diodes, applications, rectifiers, filter circuits	3	4, 5
	4.4	Zener diode voltage regulation	2	4, 5
	4.5	Transistors, amplifiers, transistor as a switch	4	4, 5
	4.6	LED, phototransistor	3	4, 5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Mehta, V. K., & Mehta, R. (n.d.). *Principles of electronics* (Chs. 1, 8–11). S. Chand & Company Ltd.
2. Sedha, R. S. (n.d.). *A textbook of applied electronics* (Ch. 33). S. Chand & Company Ltd.

Suggested Readings

1. Tewari, K. K. (n.d.). *Electricity and magnetism*.

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Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Fundamentals of renewable energy technology				
Type of Course	SDC				
Course Code	MG1SDCREM101				
Course Level	**100**				
Course Summary	This course provides a comprehensive introduction to the principles and applications of renewable energy systems. It covers the fundamental scientific and engineering concepts behind various renewable energy sources, including solar, wind and biomass energy. The course emphasizes the need for sustainable energy development, energy conversion processes, and the environmental implications of renewable energy utilization. Students will gain foundational knowledge of energy resource assessment, system components, efficiency analysis, and practical implementation of renewable technologies.				
Semester	1	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practicum/Practical**	**OJT**	
		3	1	0	75
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the classifications and characteristics of various energy sources.	K	1, 4
2	Explain the fundamental principles and working mechanism of various renewable energy sources.	U	1, 2
3	Apply the fundamental principles of energy conversion	A	1, 2
4	Analyze the performance of various solar collectors, wind system and biomass conversion systems	An	2, 7
5	To get expertise in using various components and instruments	A	1, 2 ,10
6	Analyze the performance of various biogas plants	An	2, 4, 6
**** Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	1	0	0	0	0	0	0
CO 2	3	2	0	0	0	0	0	0	0	0
CO 3	3	2	0	0	0	0	0	0	0	0
CO 4	0	3	0	0	0	0	1	0	0	0
CO 5	2	3	0	0	0	0	0	0	0	1
CO 6	0	3	0	2	0	2	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to energy sources**		**15 hrs**	
	1.1	Classification of energy sources	1	1
	1.2	Energy sources and their availability	1	1
	1.3	Conventional energy sources	2	1
	1.4	Non-conventional energy sources	2	1
	1.5	Advantages of renewable energy sources	1	1
	1.6	Practical- Familiarization and operational experience of solar energy measurement instruments	8	5
2	**Solar energy**		**20 hrs**	
	2.1	Radiation	1	2
	2.2	Solar constant	2	2
	2.3	Principle of conversion of solar radiation into heat	2	2, 3
	2.4	Solar collectors	3	4
	2.5	Solar photovoltaic system	1	4
	2.6	Greenhouse effect	1	1
	2.7	Practical- Familiarization of solar collectors	10	5
	Wind energy		**20 hrs**	

	3.1	Nature of the wind	2	2
	3.2	Wind energy conversion	3	3
	3.3	Site selection considerations	2	4
	3.4	Components of wind energy conversion system	2	4
	3.5	Applications of wind energy	3	4
	3.6	Interconnected systems	2	4
	3.7	Practical- Measurement of wind speed	6	5
4	**Biomass**		**20 hrs**	
	4.1	Categories of biomass resources	2	4
	4.2	Biomass conversion technologies	3	4
	4.3	Biogas generation	4	4
	4.4	Community biogas plants	3	4
	4.5	Materials used for biogas generation	2	4
	4.6	Practical- Analysis of performance of a biogas plant	6	6
5	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table></td></tr>
<tr><td>Practical
<table>
<tr><td colspan="2">Total Mark: 15</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Involvement</td><td>5</td></tr>
<tr><td>Punctuality</td><td>5</td></tr>
<tr><td>Record</td><td>5</td></tr>
</table></td></tr>
</table>

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Rai, G. D. (n.d.). *Non-conventional energy sources* (Chs. 1–4, 6–7). Khanna Publishers.

Suggested Readings

1. Rajput, R. K. (2012). *Non-conventional energy sources and utilization (energy engineering)* (1st ed.). S. Chand & Company Ltd.

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Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Mathematics for Renewable Energy I				
Type of Course	SDC				
Course Code	MG1SDCREM102				
Course Level	**100**				
Course Summary	This course provides a foundational understanding of essential mathematical concepts and their application using computational tools, particularly MATLAB. It is designed to strengthen the learner's analytical and problem-solving skills across a range of mathematical domains such as Number Systems,Basic Computational Techniques , Solving Equations,Matrix Operations and Applications,Trigonometric Functions and Set operations.				
Semester	1	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Recalling the basics of number systems,basic computational techniques and solving of equations	K	1,2,10
2	Understanding the basics of MATLAB	U , A	1,3
3	Analysing the different matrix operations and its applications	A , An	1,2
4	Understanding and analysing the different trigonometric functions	An	1,2
5	Understanding the different set operations	U	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	0	0	0	0	0	0	0	2
CO 2	3	0	2	0	0	0	0	0	0	0
CO 3	3	3	0	0	0	0	0	0	0	0
CO 4	3	3	0	0	0	0	0	0	0	0
CO 5	3	3	0	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Computational Mathematics**		**15 hrs**	
	1.1	Types of numbers, HCF & LCM,	2	1
	1.2	Fractions, simplifications ,squares and square roots,	2	1
	1.3	Quadratic equations and linear equations	3	1
	1.4	Practical: Performing different arithmetic and algebraic operations	8	1,2
2	**Introduction to Matrices**		**20 hrs**	
	2.1	Basic Matrix Operations: Addition, subtraction, and scalar multiplication	4	3
	2.2	Transpose of a matrix - Matrix multiplication - Special Matrices and Functions: Identity matrix - Zeros and ones matrix - Diagonal matrix	4	3
	2.3	Matrix Algebra Applications: Determinant - Inverse of a matrix - Rank of a matrix - Trace of a matrix.	4	3
	2.4	Practical : Constructing a matrix, performance of arithmetic operations and finding its inverse.	8	2 , 3
3	**Introduction to Trigonometric Functions**		**20 hrs**	
	3.1	Overview of sine and cosine functions	3	4
	3.2	Definitions and properties (periodicity, amplitude, frequency, phase shift)	3	4
	3.3	Relationship between sine and cosine	3	4
	3.4	Basics of circle geometry and parametric equations of a circle	3	4

	3.5	Practical: Plot different trigonometric functions	8	2, 4
4	**Basics of Set Theory**		**20 hrs**	
	4.1	Definition of sets and elements, Set notation and roster/tabular form	2	5
	4.2	Types of sets: finite, infinite, empty (null) set, singleton	3	5
	4.3	Subsets, proper subsets, power sets	3	5
	4.4	Set Operations: Union, intersection, difference, complement	3	5
	4.5	Properties of set operations and Cartesian product of sets	3	5
	4.6	Practical: Analysing the different set operations	6	2,5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture , discussion , problem solving , question answering , brainstorming , demonstration
Assessment Types	**MODE OF ASSESSMEN**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Program/ Demonstration	10
Skill and Performance	10
Output	10
Viva	5

References

1. Leon, S. J. (n.d.). *Discrete mathematics using MATLAB*.

2. Sharma, R. D. (n.d.). *Algebra, calculus, trigonometry, coordinate geometry, etc*.

Suggested Readings

1.Rosen, K. H. (n.d.). *Discrete mathematics and its applications*.

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Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Renewable Energy in Daily Life				
Type of Course	MDC				
Course Code	MG1MDCREM100				
Course Level	**100**				
Course Summary	This course will introduce different types of renewable energy resources like solar, wind, biomass, geothermal and nuclear and discuss solar , wind and biomass in detail.				
Semester	1	**Credits**		3	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	0	0	45
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the classification of energy sources	K, U	1, 3
2	Integrating renewable energy in daily life	A	1, 6, 8
3	Understanding the principles of energy economics and energy conservation	U	1, 3
4	Executing an environmentally sustainable attitude	A	7, 8, 10
5	Estimating the challenges in the renewable energy sector	U,An	1, 5,
6	Extending the knowledge to the society	U,A	4, 5, 6
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	1	0	0	0	0	0	0	0
CO 2	3	0	0	0	0	2	0	1	0	0
CO 3	2	0	2	0	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	3	2	0	2
CO 5	1	0	0	0	2	0	0	0	0	0
CO 6	0	0	0	3	2	1	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to energy sources**		**15hrs**	
	1.1	Classification of energy sources- primary, secondary and supplementary	2	1
	1.2	Energy sources and their availability	2	1
	1.3	The energy crisis and climate change	2	1, 2
	1.4	Importance of renewable energy in reducing carbon footprint	2	4
	1.5	Qualitative ideas of solar energy	1	1
	1.6	Wind energy, biomass	2	1
	1.7	Tidal energy and geothermal energy	1	1
	1.8	Renewable energy resources- advantages and obstacles	1	1
	1.9	Earlier applications of renewable energy	1	2
	1.10	Growth & development of renewable energy-	1	1

Module	Units	Course description	Hrs	CO No.
2	**Applications in daily life**		**15hrs**	
	2.1	Categories of solar energy applications	1	2
	2.2	solar water heating	1	2
	2.3	space heating- passive heating-direct gain	2	2,3
	2.4	thermal storage wall- attached sunspace	1	3
	2.5	roof storage- solar distillation	2	2
	2.6	qualitative ideas of solar pumping, solar furnace	1	2,4
	2.7	solar cooking, solar thermal electric conversion and solar electric power generation	2	2

	2.8	Solar street lighting and home lighting systems	1	2,4
	2.9	Biogas for cooking in rural areas	1	2,6
	2.10	Wind-powered water pumps	1	2
	2.11	Hybrid energy systems for homes and small communities.	2	2
3	**Energy conservation**		**15 hrs**	
	3.1	Economic concept of energy	3	3
	3.2	Principles of energy conservation	3	3
	3.3	Energy conservation approaches	3	3,6
	3.4	Cogeneration- types- waste heat utilization	3	3
	3.5	Heat exchanger- uses- classification.	3	3,5
4	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Leverage a blended learning approach with a mix of lectures, interactive discussions.</td></tr>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table></td></tr>
<tr><td>B. End Semester Evaluation (ESE)
Theory
<table>
<tr><td colspan="3">Total mark: 50</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 30 out of 32</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 4 out of 6</td></tr>
</table>
Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

1. Rai, G. D. (n.d.). *Non-conventional energy sources*. Khanna Publishers.

Suggested Readings

1. Garg, H. P., & Prakash, J. (n.d.). *Solar energy: Fundamentals and applications*.

2. Rajput, R. K. (2012). *Non-conventional energy sources and utilization (energy engineering)* (1st ed.). S. Chand & Company Ltd.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	On -the -Job Training				
Type of Course	SDC				
Course Code	MG1SDCREM103				
Course Level	**100**				
Course Summary	The On-Job Training (OJT) component of the B.Voc in Renewable Energy Management program is designed to provide students with real-world experience in the renewable energy sector. Through practical engagement with industry partners, students gain hands-on skills and apply theoretical knowledge acquired in classrooms to real-time projects and operations. This training bridges the gap between academic learning and industry requirements, enhancing the employability and technical competence of students. It includes activities such as installation, operation, and maintenance of solar PV systems, wind turbines, biogas units, energy auditing, project monitoring, and documentation.				
Semester	1	**Credits**		2	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		0	0	2	5hour/week
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental concepts, tools, and procedures related to renewable energy systems as applied during the training.	K	1, 2
2	Demonstrate awareness of workplace ethics, safety practices, and SOPs in the renewable energy sector.	U	8
3	Operate and maintain renewable energy equipment and systems under industry supervision.	A	2, 7, 10
4	Communicate effectively and collaborate with professionals and team members.	A, An	4, 9
5	Prepare technical reports and presentations on work experiences and learnings.	C	4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	3	0	0
CO 3	0	2	0	0	0	0	2	0	0	3
CO 4	0	0	0	2	0	0	0	0	1	0
CO 5	0	0	0	3	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT		
	A	Internal Evaluation	
		Components	**Marks**
		Feedback from the hosting organization	5
		Internal Supervisor feedback	10
		Total	**15**
	B	External Evaluation	
		Components	**Marks**
		Presentation	10
		Report	10
		Viva Voce	15
		Total	**35**

SEMESTER 2

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Energy and Power Fundamentals				
Type of Course	SDC				
Course Code	MG2SDCREM100				
Course Level	100				
Course Summary	This course introduces the basics of electrical energy and power systems, covering circuit elements, voltage and current sources, and key AC concepts like phasor representation and power. It explores load characteristics and power factor, explaining different types of loads and the importance of improving power factor. The electrical tariff and energy metering module discusses various tariff structures, meter types, and billing methods. It also focuses on energy conservation and management, highlighting the need for energy audits, efficiency standards, and government policies. Overall, the course provides a foundational understanding of power systems, energy consumption, and strategies for efficient energy use.				
Semester	2	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		4	0	0	60
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the basics of electrical energy and power systems	K	1, 2
2	Understand the fundamentals of Load Characteristics and Power Factor	U	1, 2
3	Analyze the objectives and types of Electrical Tariff and Energy Metering	An	1, 2, 6
4	Evaluate the need and methods of Energy Conservation and Management	E	1, 2, 6
**** Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }***			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	2	3	0	0	0	0	0	0	0	0
CO 3	3	3	0	0	0	2	0	0	0	0
CO 4	3	2	0	0	0	3	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO
1	**Basics of Electrical Energy and Power Systems**		**15hrs**	
	1.1	DC- Electrical circuit elements (R, L, C), Voltage and current sources	4	1
	1.2	AC- Phasor representation of sinusoidal quantities, Peak and rms values	4	1
	1.3	Concepts of power and Energy, Active power, Reactive power, apparent power	3	1
	1.4	Introduction to Power System: Generation, Transmission, Distribution.	4	1
2	**Load Characteristics and Power Factor**		**15 hrs**	
	2.1	Types of Loads: Resistive, Inductive, Capacitive	3	2
	2.2	Load Curves: Daily Load Curve-Monthly and Annual Load Curves	4	2
	2.3	Load Factor, Demand Factor, Diversity Factor, Utilization Factor	4	2
	2.4	Power and Power Factor-Importance of improving the Power Factor	4	2
3	**Electrical Tariff and Energy Metering**		**15hrs**	
	3.1	Introduction to Tariff: Objectives and Principles of a Good Tariff	5	3
	3.2	Types of Tariffs: Flat Rate Tariff, Block Rate Tariff, Two-Part Tariff, Maximum Demand Tariff, Time-of-Day Tariff-	5	3
	3.3	Energy Metering: Types of Energy Meters (Analog, Digital, Smart Meters)-Reading and Billing.	5	3
4	**Energy Conservation and Management**		**15hrs**	
	4.1	Need for Energy Conservation	1	4
	4.2	Energy Audit: Types and Methods	5	4
	4.3	Standards and Labels (BEE Star Ratings)	5	4

	4.4	Government Policies on Energy Efficiency.	4	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE) Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Gupta, J. B. (n.d.). *A course in power systems: Detailed analysis of load factor, plant factor, tariffs, transmission, and distribution.*

2.Mehta, V. K., & Mehta, R. (n.d.). *Principles of power system: Clear explanations of tariff types, load characteristics, and power factor.*

3.Kothari, D. P., & Nagrath, I. J. (2006). *Basic electrical engineering* (2nd ed.). Tata McGraw-Hill.

Suggested Readings

1.Bureau of Energy Efficiency. (n.d.). *General aspects of energy management and energy audit* (Book 1). Government of India.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Solar photovoltaic systems				
Type of Course	SDC				
Course Code	MG2SDCREM101				
Course Level	100				
Course Summary	This course will introduce solar cells- its construction, characteristics, uses and applications.It also discusses solar photovoltaic system design, battery systems and grid interfacing. Also introduce few topics related to electrical wiring				
Semester	2	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Display a comprehensive technological understanding in solar PV components	A	1, 2
2	Understand solar PV system design	U	2, 9
3	Display knowledge and skills to design, analyze, and optimize battery-powered systems for grid integration.	A	1, 2
4	Identify appropriate equipment, construct circuits, follow safety protocols, troubleshoot common faults, and understand electrical standards.	K,U	1, 2, 5
5	Analyse photovoltaic system performance and design	An	1, 2 7
6	Analyze the performance of various PV plants	An	1, 2, 6
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	1	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	2	3	0	0	1	0	0	0	0	0
CO 5	2	2	0	0	0	0	1	0	0	0
CO 6	1	2	0	0	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Solar Photovoltaic cell**		**20hrs**	
	1.1	Solar Cell and its function, types	2	1
	1.2	Equivalent circuit diagrams of solar cells	2	1
	1.3	Solar Cell Parameters, Efficiency of Solar Cell	2	1
	1.4	Solar PV Module, Types of modules, Rating of Solar PV Module, PV Module Parameters, Efficiency of PV Module	2	1
	1.5	Measuring Module Parameters- Module cable outlets and junction boxes -Wiring symbols	2	1
	1.6	Characteristic I-V curves for modules -Irradiance dependence and temperature characteristics- Hot spots, bypass diodes and shading-Quality certification for modules.	2	1
	1.7	Practical : Familiarize appropriate access equipment and basic roofing techniques for PV module installation, Carry out measurements within module and array	8	1,5,6
2	**Solar PV system design**		**20hrs**	
	2.1	Design and functioning of a silicon solar cell	3	2
	2.2	Design options for PV modules- standalone photovoltaic system design	3	2
	2.3	Connection of PV Module in Series and Parallel	3	2
	2.4	Estimation and Measurement of PV Module Power, Selection of PV Module. Maximum Power Point Tracking.	3	2,5
	2.5	Practical : Illuminated IV characteristics of a solar cell – calculation of fill factor and efficiency, Series and parallel connection of solar cells, IV characteristics with series combination of modules, IV characteristics with parallel combination of modules	8	2,5,6

3	**Battery systems and Grid interfacing** **15hrs**			
	3.1	Batteries- type of batteries	2	3
	3.2	battery parameters-selection and maintenance.	3	3
	3.3	Grid synchronization-voltage considerations and power evacuation	3	3
	3.4	Practicum : Battery management system implementation	7	3,6
4	**Electrical Wiring**		**20rs**	
	4.1	Types of Wire, Wire Sizing	3	4
	4.2	Junction Box, DC cabling, AC cabling	3	4
	4.3	Array Combiner Box, AC Distribution Box, Energy Metering	4	4
	4.4	Electrical Grounding, Earth Resistance and Insulation Resistance Measurements.	3	4
	4.5	Practicum : Hands on exercises and experiments related to installing and troubleshooting electrical systems	7	4,6
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE) Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. The German Energy Society. (2008). *Planning and installing photovoltaic systems: A guide for installers, architects and engineers* (2nd ed.). Earthscan.

Suggested Readings

1. Rai, G. D. (n.d.). *Non-conventional energy sources.* Khanna Publishers.

2. Rajput, R. K. (2012). *Non-conventional energy sources and utilization (Energy engineering)* (1st ed.). S. Chand & Company Ltd.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Mathematics for Renewable Energy- 2				
Type of Course	SDC				
Course Code	MG2SDCREM102				
Course Level	**100**				
Course Summary	This course provides a foundational understanding of essential mathematical concepts and their applications. It is designed to strengthen the learner's analytical and problem-solving skills across a range of mathematical domains such as Logic Gates, Conic Sections, Linear Programming Problem and Graph Theory				
Semester*	2	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental concepts of Boolean algebra and its operations.	U	1, 2, ,3
2	Identifying and applying the standard equations of conic sections	A	1, 2
3	Formulating real-world optimization problems as linear programming models	C	1, 2
4	Creating an insight into the basics of graph theory	U	1, 2
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	0	0	0	0	0	0	0
CO 2	3	3	0	0	0	0	0	0	0	0
CO 3	3	3	0	0	0	0	0	0	0	0
CO 4	3	3	0	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Logic Gates**	**15hrs**	
	1.1	Boolean Functions	3	1
	1.2	Representing Boolean Functions and Logic gates- AND, OR, NOT, XOR, XAND, NAND	3	1
	1.3	Truth table and its Circuits	3	1
	1.4	Practical :Realization of logic gates using diodes and transistors.	6	1
2		**Conic Sections**	**20 hrs**	
	2.1	Conic Sections- Standard equations - circle, parabola, ellipse, hyperbola.	6	2
	2.2	Shifting of circle, parabola, ellipse, and hyperbola.	6	2
	2.3	Practical : Plotting different conic sections using geogebra	8	2
3		**Linear Programming Problem**	**20 hrs**	
	3.1	LPP and its mathematical formulation	6	3
	3.2	Graphical method of solving LPP	6	3
	3.3	Practical : Solving LPP and finding the feasible region using geogebra	8	3
4		**Graph Theory**	**20 hrs**	
	4.1	Definitions and examples, connectedness, adjacency	2	4
	4.2	Sub graphs, matrix representation, null graphs	3	4

	4.3	Complete graphs, cyclic graphs, path graphs and wheels	3	4
	4.4	Regular graphs, bipartite graphs, complement of a simple graph.	4	4
	4.5	Practical : Sketching different types of graphs	8	4
5		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture , discussion , problem solving , question answering , brainstorming , demonstration
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory**

Total Mark: 25

Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15

Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Program/ Demonstration	10
Skill and Performance	10
Output	10
Viva	5

References

1. Rosen, K. H. (n.d.). *Discrete mathematics and its applications.*
2. Wilson, R. J. (n.d.). *Introduction to graph theory*.
3. Sharma, R. D. (n.d.). *Linear programming problem.*

Suggested Readings

1. Chartrand, G., & Zhang, P. (n.d.). *A first course in graph theory*.

Mahatma Gandhi University Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Energy efficient buildings</td></tr>
<tr><td>Type of Course</td><td colspan="5">MDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG2MDCREM100</td></tr>
<tr><td>Course Level</td><td colspan="5">100</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the fundamentals of designing and evaluating buildings with a focus on energy efficiency and sustainability. It covers key concepts such as energy conservation, building envelope design, and the role of natural lighting, ventilation, and insulation in reducing energy demand. Students will learn about various systems affecting building energy performance and develop the skills to create or retrofit buildings that minimize energy consumption while maintaining occupant comfort and environmental responsibility.</td></tr>
<tr><td>Semester*</td><td>2</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practicum/Practical</td><td>OJT</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify key components and systems that influence energy performance in buildings	K, U	1
2	Understand the principles of energy conservation and sustainability in building design.	U	1
3	Analyze the effect of various passive heating and cooling methods and day lighting.	An	2
4	Demonstrate awareness of green building rating systems.	U, A	1, 6
5	Design energy-efficient building layouts to reduce energy consumption.	U, A	4, 10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	0	0	0	0	0	0	0
CO 2	3	0	0	0	0	0	0	0	0	0
CO 3	0	3	0	0	0	0	0	0	0	0
CO 4	1	0	0	0	0	2	0	0	0	0
CO 5	0	0	0	2	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Energy transfer and heat control in buildings**		**20hrs**	
	1.1	Concept of energy efficient buildings	2	1
	1.2	Heat losses and Stack effect	2	1
	1.3	Influence of climate in building design	2	1, 2
	1.4	Thermal design	1	2
	1.5	Heating and cooling load	2	1
	1.6	Zero energy buildings	1	1
	1.7	Practical- Visit an energy efficiency building in nearby area	10	5

Module	Units	Course description	Hrs	CO No.
2	**Passive solar heating and cooling**		**10hrs**	
	2.1	Principles of solar heating, direct, indirect and isolated heating	2	3
	2.2	Concepts of trombe wall and water wall	1	3
	2.3	Passive cooling, ventilation- design for natural ventilation- reradiation- evaporative cooling- thermal insulation	2	3
	2.4	Air filtration and odour removal in buildings	1	3
	2.5	Practical- Calculate the ventilation size of the classroom/lab	4	3

3	**Day lighting and Green buildings**		**30hrs**	
	3.1	Materials for day lighting, insulation- radiant barrier	2	3
	3.2	Sources of daylighting, building design strategies- daylight factor- components	2	3
	3.3	Daylighting analysis	2	3
	3.4	Electric lighting, illumination requirements in daylighted buildings	2	3
	3.5	Features of green buildings, green materials- integrated ecological design	2	4
	3.6	Sustainable site, landscaping enhancing ecosystem, microclimate	2	4
	3.7	High performance green buildings, economics, management, environment benefits	2	4
	3.8	Practical- Analyze the electrical lighting requirements of the given room	16	3
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions
Assessment Type	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 15	
Assessment methods	
Assignment	5
Seminar/ Quiz/ Group Discussion	5
Test	5

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE) Theory

Total mark: 35		
Assessment methods: Written Exam		
Duration of Examination: 1 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 20 out of 22
Part B	5 mark	Answer any 3 out of 5

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Understanding and application of concept	10
Data collection and analysis	10
Presentation	10
Viva	5

References

1. Majumdar, M. (n.d.). *Energy efficient building in India*. Tata Energy Research Institute, Ministry of Non-Conventional Energy Sources.
2. Garg, H. P., & Prakash, J. (n.d.). *Solar energy: Fundamentals and applications*.

<table>
<tr><td colspan="6">Mahatma Gandhi University
Kottayam</td></tr>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">On- the -Job Training</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG2SDCREM103</td></tr>
<tr><td>Course Level</td><td colspan="5">100</td></tr>
<tr><td>Course Summary</td><td colspan="5">The On-Job Training (OJT) component of the B.Voc in Renewable Energy Management program is designed to provide students with real-world experience in the renewable energy sector. Through practical engagement with industry partners, students gain hands-on skills and apply theoretical knowledge acquired in classrooms to real-time projects and operations.

This training bridges the gap between academic learning and industry requirements, enhancing the employability and technical competence of students. It includes activities such as installation, operation, and maintenance of solar PV systems, wind turbines, biogas units, energy auditing, project monitoring, and documentation.</td></tr>
<tr><td>Semester</td><td>2</td><td colspan="2">Credits</td><td>2</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental concepts, tools, and procedures related to renewable energy systems as applied during the training.	K	1, 2
2	Demonstrate awareness of workplace ethics, safety practices, and SOPs in the renewable energy sector.	U	8
3	Operate and maintain renewable energy equipment and systems under industry supervision.	A	2, 7, 10
4	Communicate effectively and collaborate with professionals and team members.	A, An	4, 9
5	Prepare technical reports and presentations on work experiences and learnings.	C	4
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	3	0	0
CO 3	0	2	0	0	0	0	2	0	0	3
CO 4	0	0	0	2	0	0	0	0	1	0
CO 5	0	0	0	3	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

<table>
<tr><td rowspan="13">Assessment Types</td><td colspan="3">MODE OF ASSESSMENT</td></tr>
<tr><td>A</td><td colspan="2">Internal Evaluation</td></tr>
<tr><td rowspan="4"></td><td>Components</td><td>Marks</td></tr>
<tr><td>Feedback from the hosting organization</td><td>5</td></tr>
<tr><td>Internal Supervisor feedback</td><td>10</td></tr>
<tr><td>Total</td><td>15</td></tr>
<tr><td>B</td><td colspan="2">External Evaluation</td></tr>
<tr><td rowspan="5"></td><td>Components</td><td>Marks</td></tr>
<tr><td>Presentation</td><td>10</td></tr>
<tr><td>Report</td><td>10</td></tr>
<tr><td>Viva Voce</td><td>15</td></tr>
<tr><td>Total</td><td>35</td></tr>
</table>

SEMESTER 3

	Mahatma Gandhi University **Kottayam**

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Material Science for Renewable Energy Technology</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG3SDCREM200</td></tr>
<tr><td>Course Level</td><td colspan="5">200</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the fundamental properties, testing methods, and environmental effects on engineering materials such as metals, polymers, semiconductors, and nanomaterials. It covers the role of materials in renewable energy, including applications of nanomaterials and biodegradable polymers. Emphasis is placed on practical understanding of material behavior, performance, and sustainability for real-world renewable energy systems.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamental properties of various materials and nanomaterials, and their applications in renewable energy, electronics, healthcare, and environmental contexts.	U, A. Ap	2,10
2	Gain knowledge of the concepts of stress, strain, and deformation, and analyze the mechanical behavior of materials under various conditions.	K, An ,A	2
3	Identify and analyze the environmental effects on materials and failure mechanisms of solar materials.	An ,E	6,7
4	To understand natural and synthetic polymers and evaluate their environmental impacts.	U,E	2,6,7
5	Conduct a comparative analysis of natural and synthetic polymers, focusing on their environmental impacts and the role of biodegradable alternatives in sustainable material development.	E,C	1,6,7
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	3	0	0	0	0	0	0	0	2
CO 2	0	3	0	0	0	0	0	0	0	0
CO 3	0	0	0	0	0	3	2	0	0	0
CO 4	0	2	0	0	0	2	2	0	0	0
CO 5	2	0	0	0	0	2	3	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Properties of Materials**	**19 hrs**	
	1.1	Mechanical, Optical, Thermal Electrical and Magnetic Properties of Metals, Alloys, Semiconductors, Polymers, Glass, Nanomaterials and Magnetic Materials	5	1
	1.2	Superconductivity and Applications. Nanomaterials-properties	5	1
	1.3	Nanomaterials in renewable energy, Nanocatalysts in hydrogen generation, Nanocoatings for solar cells, Sensors, Photodetectors, LEDs, Drug delivery and diagnostics (basic overview)	5	1
	1.4	Environmental and military concerns: destructive uses of nanomaterials.	4	1
2		**Testing of Materials**	**15 hrs**	
	2.1	Concepts of Stress and Strain, Hooke's Law, Tension, Compression and Shear	5	2
	2.2	Stress-strain Diagram and Thermal Stresses	4	2
	2.3	Elasticity in Metals and Polymers, Plastic Deformation, Yield Stress, Shear Strength, Strengthening Mechanisms	6	2
3		**Effects on Materials**	**10 hrs**	
	3.1	Environmental Effects - Corrosion, Erosion, Thermal Stress and Weathering Properties of Solar Materials	5	3
	3.2	Effect of Temperature, Fracture Behavior of Various Materials, Failure Analysis of Solar Materials	5	3
4		**Natural and Synthetic Polymers**	**16 hrs**	
	4.1	Classification - Natural and Synthetic	3	4
	4.2	Types - linear, branched, cross-linked, Common polymers - Polyethene, PVC, Nylon, Polyester – Rubber	5	4
	4.3	Natural and synthetic types - Natural rubber: structure, vulcanization, Synthetic rubbers: basic examples (SBR, neoprene)	5	4
	4.4	Environmental impact of plastics – Biodegradable Polymers	3	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

Assessment Types

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Ramamrutam, S. (2010). *Strength of materials* (16th ed.). Danpat Rai Publications.
2. Callister, W. D. (2009). *Materials science and engineering* (6th ed.). Wiley India.
3. Sheckel Ford, J., & Muralidham, M. K. (2007). *Introduction to materials science for engineers* (6th ed.). Pearson.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Solar Thermal Technology				
Type of Course	SDC				
Course Code	MG3SDCREM201				
Course Level	200				
Course Summary	This course provides a comprehensive overview of solar thermal energy systems, focusing on the principles, design, and applications of technologies that harness solar energy for thermal use. It covers the fundamentals of solar radiation, various types of solar thermal collectors, and energy storage techniques. Students will explore thermal system design for water heating, space heating, industrial process heat, and power generation.				
Semester	3	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	Basic thermodynamics				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Recall the basic principles of solar radiation and thermal energy conversion.	K	1
2	Explain the working principles and classifications of various solar thermal collectors.	U	1
3	Apply heat transfer and thermodynamic concepts to analyze the performance of solar thermal systems.	A	1, 6
4	Analyze the design and efficiency parameters of solar water heating and space heating systems.	An	2
5	Understand the principles of energy conservation and sustainability in building design.	U	4, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	0	0	0	0	0	0	0
CO 2	3	0	0	0	0	0	0	0	0	0
CO 3	2	0	0	0	0	1	0	0	0	0
CO 4	0	3	0	0	0	0	0	0	0	0
CO 5	0	0	0	3	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Solar Radiation**		**15 hrs**	
	1.1	Sun as the source of radiation- direct and diffuse radiation	2	1
	1.2	Solar constant- variation of radiation- basic earth sun angles- solar time	2	1
	1.3	Basic earth sun angles- solar time	3	1
	1.4	Measurement of solar radiation- Pyranometer, Pyrheliometer, Sunshine recorder.	4	1
	1.5	Practical- Study the hourly Variation of solar radiation.	4	1
2	**Solar Collectors**		**20 hrs**	
	2.1	Flat plate collectors- liquid flat plate collectors- materials for flat plate collector	2	2
	2.2	Heat loss- factors affecting the efficiency and improvement- effect of inclination and dust	2	2
	2.3	Flat plate air heating collectors- types- two pass solar air heater- overlapped glass plate air heater- matrix air heater- honeycomb porous bed air heater	2	2
	2.4	Solar pond	1	2
	2.5	Tubular solar energy collectors- concentric tube collectors	2	2
	2.6	Solar concentrating collectors- parameters- classifications- cylindrical and compound parabolic collectors	3	2
	2.7	Mountings- tracking requirement of compound parabolic concentrating collectors- point focusing solar concentrators- central power receiver. systems- heliostat- materials	2	2
	2.8	Practical- 1. Effect of tilt angle on solar thermal collector efficiency of a flat plate collector 2. Thermosyphonic mode of flow in flat plate collector and evaluation of parameters.	6	2, 3

3		**Solar Thermal Applications**	**20 hrs**	
	3.1	Solar water heating- swimming pool heating- built in storage type- separate collector and storage type- natural circulation- forced circulation	2	4
	3.2	Solar cookers- types- solar desalination- simple solar still-basics- solar disinfection	2	4
	3.3	Solar dryers- basics- types (qualitative idea only)- Solar furnace- types- components- designs	3	4
	3.4	Solar greenhouse- greenhouse design- orientation and tilt-modes of heat transfer- glass or plastic greenhouse- Brace greenhouse design- KISR design	3	4
	3.5	Practical- 1. Evaluation of efficiency in solar still 2. Demonstration of solar cooker and dryer	10	3, 4
4		**Solar Heating and Cooling of Buildings**	**20 hrs**	
	4.1	Passive solar heating- direct gain- thermal storage wall-attached greenhouse- thermal storage roof- convective loop	3	5
	4.2	Passive cooling- shading- ventilation- evaporation-radiation cooling- ground coupling- dehumidification	2	5
	4.3	Active solar heating- building form and functions- general aspects- components- solar collector- thermal storage system- heat supply system- control systems- heating load and sizing	3	5
	4.4	Qualitative ideas of solar refrigerator and air conditioning	2	5
	4.5	**Practical**: Estimation of ventilation parameters of a building Analyze the heating and cooling requirements of the given building	10	5
5		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

	Practical <table><tr><td colspan="2">**Total mark: 35**</td></tr><tr><td colspan="2">**Duration of Examination: 2 hrs**</td></tr><tr><td colspan="2">**Assessment methods**</td></tr><tr><td>Theory/ Procedure</td><td>10</td></tr><tr><td>Skill and Performance</td><td>10</td></tr><tr><td>Calculation and Result</td><td>10</td></tr><tr><td>Viva</td><td>5</td></tr></table>

References

1. Garg, H. P., & Prakash, J. (n.d.). *Solar energy: Fundamentals and applications* (Chapters 1, 2, 3, 4, 5, 6, 7, 11, 13).

Suggested Readings

1. Tiwari, G. N. (n.d.). *Solar energy: Fundamentals, design, modelling and applications*. Narosa Publishing House.

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme Faculty/ Discipline</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Aerodynamics for wind turbine generators</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG3SDCREM202</td></tr>
<tr><td>Course Level</td><td colspan="5">200</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the basic principles of aerodynamics as applied to wind energy systems. It covers how wind interacts with turbine blades to generate power. Key topics include airflow patterns, lift and drag forces, blade design, Betz's limit, and performance analysis.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practicum/Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the evolution of wind energy, basic wind power concepts, turbine performance parameters, and the classification and working of horizontal and vertical axis wind turbines.	U, An, A	1,2,3, 10
2	Grasp fundamental fluid mechanics, airfoil behavior, and aerodynamic theories to analyze rotor design and wind turbine performance.	An, A, E	1, 2
3	learn about wind behavior influenced by environmental and local effects, and understand methods and instruments for wind measurement and classification.	U , An, A	2, 3, 6
4	Analyze wind data using statistical models, interpret turbine performance through power curves and coefficients, and understand control strategies including pitch, yaw, and turbine speed regulation.	A, An, E	1, 2, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	3	0	0	0	0	0	0	3
CO 2	3	3	0	0	0	0	0	0	0	0
CO 3	0	2	2	0	0	3	0	0	0	0
CO 4	3	3	0	0	0	0	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Wind Energy**		**15 hrs**	
	1.1	History of wind energy	2	1
	1.2	Wind Generation, Kinetic energy of wind, Wind turbine power and torque, Tip speed ratio, Betz limit.	3	1
	1.3	Classification of wind turbines, Horizontal axis wind turbines, Vertical axis wind turbines.	2	1
	1.4	Practical: Measurement of Wind Speed and Direction, Power Output	8	1
2	**Aerodynamics of turbine**		**20 hrs**	
	2.1	Fluid Mechanics Basics-Conservation laws: mass, momentum, and energy-Bernoulli's equation and pressure fields	4	2
	2.2	Air foil Theory: Air foil geometry-Lift and drag forces characteristics - Reynolds number effects - Axial momentum theory, Blade element theory, Strip theory	4	2
	2.3	Rotor Design and performance analysis.	4	2
	2.4	Practical: Study of Wind Turbine Components and using Q blade software for design Airfoil and blade.	8	2
3	**Analysis of wind regimes**		**20 hrs**	
	3.1	The wind- Coriolis effect, Local effects, Wind shear, Turbulence, Acceleration effect.	5	3
	3.2	Measurement of wind, Ecological indicators – Putnam classification	3	3
	3.3	Anemometers, Wind vane.	2	
	3.4	Practical: Study of Wind Turbine Components and using Q blade software	10	3
	Performance and Optimization		**20 hrs**	

4	4.1	Average wind speed, Wind rose, Distribution of wind velocity	5	4
	4.2	Statistical models for wind data analysis: Weibull distribution, Rayleigh distribution, Constant speed turbine and variable speed turbines.	5	4
	4.3	Power curve- Performance Analysis and Power Coefficients -Tip Speed Ratio (TSR) - Capacity factor and power curves	2	4
	4.4	Control Strategies and Yaw Aerodynamics: Pitch and yaw control - Stall-regulated vs. pitch-regulated turbines.	4	4
	4.5	Practical: Visit to wind farm or test facility	4	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Practical, Group discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50
Assessment methods: Written Exam
Duration of Examination: 1.5 hrs
Pattern of Examination: Non-MCQ

Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Sathyajith, M. (2006). *Wind energy: Fundamentals, resource analysis and economics*. Springer.

Additional Readings

1. Johnson, G. L. (2006). *Wind energy systems* (Electronic ed.). Prentice Hall Inc.
2. Burton, T., Sharpe, D., Jenkins, N., & Bossanyi, E. (2001). *Wind energy handbook*. John Wiley.
3. Jha, A. R. (2011). *Wind turbine technology*. CRC Press, Taylor & Francis.
4. Jain, P. (2011). *Wind energy engineering*. McGraw-Hill.

Mahatma Gandhi University Kottayam

Faculty/ Discipline	Science				
Programme					
Course Name	Introduction to solar cells and applications				
Type of Course	MPC				
Course Code	MG3MPCREM200				
Course Level	**200**				
Course Summary	This course introduces the fundamentals of solar cells, including their working principles, types, and materials used. It covers practical applications in energy systems and highlights the role of solar technology in sustainable development.				
Semester	3	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamentals of solar energy, including solar radiation properties, measurement techniques, and the advantages and limitations of solar energy.	K, U	1, 2, 10
2	Explain the working principles of solar cells, including semiconductor physics, the photovoltaic effect, and I-V characteristics, along with factors affecting performance.	U, An	2, 3, 10
3	Identify and compare different types of solar cells, including traditional crystalline, thin-film, and emerging solar technologies.	U, An	1, 3, 7
4	Apply knowledge of solar cells in various real-world applications such as residential systems, solar gadgets, grid-tied and off-grid setups.	A, Ap, S	2, 4, 6
5	Perform basic solar energy experiments and demonstrations, including measuring solar radiation, analyzing I-V curves, and assembling simple solar devices.	A, An, S	2, 5, 9
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	2
CO 2	0	2	3	0	0	0	0	0	0	2
CO 3	2	0	2	0	0	0	2	0	0	0
CO 4	0	2	0	2	0	2	0	0	0	0
CO 5	0	2	0	0	2	0	0	0	3	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Basics of Solar Energy**	**19 hrs**	
	1.1	Introduction to renewable energy	4	1
	1.2	Solar radiation and its properties	2	1
	1.3	Solar spectrum and measurement	4	1
	1.4	Advantages and limitations of solar energy	2	1
	1.5	Practical: Study the hourly Variation of solar radiation.	7	5
2		**Solar Cell Fundamentals**	**18 hrs**	
	2.1	Working principle of a solar cell	2	2
	2.2	Semiconductor materials used	2	2
	2.3	PN junction and photovoltaic effect	2	2
	2.4	I-V characteristics of solar cells- Efficiency and factors affecting performance.	4	2
	2.5	Practical: I-V Characteristics of a Solar Cell	8	5
3		**Types of Solar Cell**	**13 hrs**	
	3.1	Crystalline silicon solar cells - Thin-film solar cells (CdTe, CIGS, a-Si)	5	3
	3.2	Emerging technologies (Perovskite, Organic, Dye-sensitized).	5	3
	3.3	Practical: Compare different types of small solar cells.	3	5

4	**Applications of Solar Cells**	**25 hrs**		
	4.1	Solar panels for homes and buildings	5	4
	4.2	Solar-powered lights and gadgets-	3	4
	4.3	Solar farms and grid-connected systems - Off-grid solar applications (pumps, chargers, etc.)	5	4
	4.4	Practical: Assemble a basic solar-powered LED light.	12	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Sukhatme, S. P., & Nayak, J. K. (n.d.). *Solar energy: Principles of thermal collection and storage*. Tata McGraw-Hill.
2. Dunlop, J. P. (n.d.). *Photovoltaic systems*.
3. Würfel, P. (n.d.). *Physics of solar cells*.
4. Solanki, C. S. (n.d.). *Solar photovoltaics: Fundamentals, technologies and applications*.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	IKS for renewable energy transformation in Kerala				
Type of Course	MDC				
Course Code	MG3MDCREM200				
Course Level*	200				
Course Summary	To introduce students to the rich traditions of Indian Knowledge Systems (IKS), their relevance to present-day renewable energy technologies, and how traditional wisdom—particularly from regions like Kerala—can be integrated with modern approaches for sustainable development.				
Semester	**3**	**Credits**		**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	**0**	**0**	**45**
Pre-requisites, if any	NIL				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the principles and practices of Indian Knowledge Systems.	R, U ,A ,An	4
2	Appreciate Kerala’s role in advancing sustainable, traditional energy and agricultural practices.	R, U, A, An	1
3	Analyze how IKS can be integrated with modern renewable energy technologies.	U, An, A	2,3,4
4	Apply the principles and values derived from IKS in contemporary personal, professional, and societal challenges.	U	1,3,5
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	0	0	3	0	0	0	0	0	0
CO 2	1	0	0	0	0	0	0	0	0	0
CO 3	0	3	3	0	0	0	0	0	0	0
CO 4	3	0	3	0	3	0	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to IKS**	**15 hrs**	
	1.1	Overview of IKS, Historical evolution of IKS across India, with emphasis on Kerala's contributions:	3	1
	1.2	Kerala's IKS legacy -Siddha and Ayurveda, traditional water management systems, temple-based astronomy.	5	1
	1.3	Traditional calendars (*Panchangam*), solar-lunar calculations used for agricultural and energy-related decisions.	4	1
	1.4	Frameworks for integrating IKS with modern renewable energy policies.	3	4
2		**Integration of IKS and Modern Technologies**	**15hrs**	
	2.1	Solar Energy: Ancient Indian and Kerala-based astronomical systems for sun-tracking -Surya Namaskara, solar temples like Konark and Thrissur Pooram alignments.	5	2
	2.2	Integration of ancient solar wisdom with modern solar PV and thermal System	5	2

	2.3	Traditional Kerala architecture (Nalukettu) for passive solar lighting and ventilation.	5	2
3	**Sustainable Agriculture and Energy**		**15hrs**	
	3.1	Biomass and Bioenergy-Use of cow dung, coconut shells, and agricultural waste in Kerala homes for cooking and heating.Practices in Kerala's farming communities.	6	3
	3.2	Transition to modern biogas plants and community-scale biomass energy systems. Traditional biogas	5	3
	3.3	Modern Efforts: Kerala State Electricity Board (KSEB)'s initiatives in solarization and green energy corridors.	4	3
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions.
	MODE OF ASSESSMENT
Assessment Types	**A. Continuous Comprehensive Assessment (CCA) Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)

Theory

<table>
<tr><td colspan="3">Total mark: 50</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 30 out of 32</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 4 out of 6</td></tr>
</table>

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Mahadevan, B., Pisupati, B., & Kannan, K. S. (n.d.). *Introduction to Indian knowledge system: Concepts and applications*. PHI Learning.
2. Chattopadhyaya, D. (n.d.). *Science and technology in ancient India*. People's Publishing House.
3. Rai, G. D. (n.d.). *Non-conventional energy resources*. Khanna Publishers.

Suggested Readings

1. Kannan, K. P. (Ed.). (n.d.). *Kerala: Exploring future frontiers of development*. CDS & UNDP.
2. All India Council for Technical Education. (n.d.). *Indian knowledge systems booklet*. https://iksindia.org
3. Ministry of New and Renewable Energy, India. (n.d.). *MNRE reports*. https://mnre.gov.in
4. National Innovation Foundation. (n.d.). *Reports (traditional technologies)*. https://nif.org.in

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">On –the- Job Training</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG3SDCREM203</td></tr>
<tr><td>Course Level</td><td colspan="5">200</td></tr>
<tr><td>Course Summary</td><td colspan="5">The On-Job Training (OJT) component of the B.Voc in Renewable Energy Management program is designed to provide students with real-world experience in the renewable energy sector. Through practical engagement with industry partners, students gain hands-on skills and apply theoretical knowledge acquired in classrooms to real-time projects and operations.

This training bridges the gap between academic learning and industry requirements, enhancing the employability and technical competence of students. It includes activities such as installation, operation, and maintenance of solar PV systems, wind turbines, biogas units, energy auditing, project monitoring, and documentation.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="2">Credits</td><td>2</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>5 hour/week</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental concepts, tools, and procedures related to renewable energy systems as applied during the training.	K	1, 2
2	Demonstrate awareness of workplace ethics, safety practices, and SOPs in the renewable energy sector.	U	8
3	Operate and maintain renewable energy equipment and systems under industry supervision.	A	2, 7, 10
4	Communicate effectively and collaborate with professionals and team members.	A, An	4, 9
5	Prepare technical reports and presentations on work experiences and learnings.	C	4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	3	0	0
CO 3	0	2	0	0	0	0	2	0	0	3
CO 4	0	0	0	2	0	0	0	0	1	0
CO 5	0	0	0	3	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	**MODE OF ASSESSMENT**		
	A	**Internal Evaluation**	
		Components	**Marks**
		Feedback from the hosting organization	5
		Internal Supervisor feedback	10
		Total	**15**
	B	**External Evaluation**	
		Components	**Marks**
		Presentation	10
		Report	10
		Viva Voce	15
		Total	**35**

SEMESTER 4

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Sustainable development and climate changes				
Type of Course	SDC				
Course Code	MG4SDCREM200				
Course Level	200				
Course Summary	This course introduces the principles of sustainable development and the science of climate change. It explores the interdependence of environmental, social, and economic systems, the impacts of global warming, and the strategies for mitigation and adaptation.				
Semester	4	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		4	0	0	60 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the principles, evolution, and legal framework of sustainable development from global and Indian perspectives.	U, An	1, 2, 6,7
2	Explain the causes, scientific evidence, and regional impacts of climate change on ecosystems, health, and economies.	U, E	2, 1, 6, 7
3	Apply climate-responsive and resource-efficient design principles to promote sustainable building practices.	U, S	3,2, 7, 10
4	Analyze water quality parameters and sustainable treatment methods for effective water management and reuse.	An, A	2, 3, 6
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	2	1	0	0	0
CO 2	2	3	0	0	0	2	1	0	0	0
CO 3	0	2	3	0	0	0	2	0	0	1
CO 4	0	3	2	0	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Fundamentals of Sustainable Development 14 hours**			
	1.1	Concept and evolution of sustainable development.	3	1
	1.2	Triple bottom line: Economic viability, Social equity, and Environmental protection, Global and Indian perspectives on sustainability.	4	1
	1.3	Overview of key Environmental Legislations in India: The Environment Protection Act (1986),The Air (Prevention and Control of Pollution) Act (1981),The Water (Prevention and Control of Pollution) Act (1974),Biological Diversity Act (2002).	7	1
2	**Climate Change – Causes and Impacts 16 hours**			
	2.1	Basics of climate systems-Natural vs. anthropogenic climate change	2	2
	2.2	The greenhouse effect and key GHGs, Evidence of climate change: temperature rise, sea level changes, glaciers, and weather anomalies.	5	2
	2.3	Ozone layer depletion- Causes of Ozone Layer Depletion-Consequences of Ozone Layer Depletion	4	2
	2.4	Regional impacts of climate change in India (Himalayan region, coastal zones),.	5	2
3	**Sustainable Design 16 hours**			
	3.1	Concepts of climate-responsive and resource-efficient design	2	3
	3.2	Orientation, Thermal Mass, Insulation, Ventilation, Shading - Material Selection, Water Efficiency, Energy Efficiency, Waste Reduction, Indoor Environmental Quality	5	3
	3.3	Examples of Climate-Responsive and Resource-Efficient Design, Green Construction	4	3
	3.4	IGBC and GRIHA certification systems, Introduction to LEED certification framework.	5	3

4		**Sustainable Water Management**	**14 hours**	
	4.1	Basics of water quality: physical, chemical, and biological characteristics	3	4
	4.2	Wastewater generation sources and classifications	2	4
	4.3	Primary, secondary, and tertiary treatment processes (Activated sludge process, Granular filtration,Reverse Osmosis)	3	4
	4.4	Sustainable water management and reuse in agriculture and industry.	2	4
	4.5	Energy Planning Tools – ENPEP, MARKAL, LEAP, MAED.	4	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Bharucha, E. (n.d.). *Environmental studies*.
2. Agarwal, S. K. (n.d.). *Climate change and environment*.

Suggested Readings

1. Majumdar, M. (n.d.). *Energy efficient buildings in India*. TERI.
2. Modi, P. N. (n.d.). *Wastewater engineering*.
3. Centre for Science and Environment. (n.d.). *Down to Earth reports and articles*.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Hydropower System				
Type of Course	SDC				
Course Code	MG4SDCREM201				
Course Level	200				
Course Summary	This provides a comprehensive understanding of hydropower, covering its basic principles, types of plants, major components, and recent innovations in the field. It highlights the role of hydropower in sustainable energy development, particularly in rural electrification. Through practical experiments, case studies, and assignments, students gain both theoretical knowledge and hands-on experience in hydropower systems and technologies.				
Semester	4	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamental principles, global trends, and environmental implications of hydropower, and recognize its role in clean and rural energy development.	K,U	2,6,7
2	To classify different types of hydropower plants and identify the key components and site selection criteria based on hydrological and geographical factors	U,A	2,3
3	Describe the components and working principles of hydropower plants, including turbine types, generators, control systems, and supporting infrastructure.	U,A,An	1,2
4	Explore modern innovations and sustainable technologies in hydropower, including advanced turbine designs, hybrid systems, and digitalization, while recognizing their environmental and operational benefits.	U, An	6,7,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	3	0	0	0	2	2	0	0	0
CO 2	0	3	2	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	0	0	0	0	0	2	2	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Fundamentals of Hydropower**	**15 hrs**	
	1.1	Introduction to Hydropower- Definition, principles, and historical development, Water energy to mechanical to electrical conversion (simple flow)	2	1
	1.2	Global Status of Hydropower: Trends, developments, and capacity distribution. Importance of hydropower in rural and clean energy development Advantages and Disadvantages of Hydropower Systems. Environmental Issues and Sustainability in Hydropower Projects	5	1
	1.3	Practical: Compare Solar, Wind, and Water Models, Making Electricity with Water, water flow measurement.	8	1
2		**Types of Hydropower Projects and Planning**	**20 hrs**	
	2.1	Classification of Hydropower Plants: Small, Medium, and Large Hydro, Run-of-the-River and Reservoir-based Projects	4	2
	2.2	Hydrological Cycle and Basics of Hydrology, Selection Criteria for Hydropower Plant Sites, Hydrological and Geographical Factors	4	2
	2.3	Essential Elements of a Hydropower Project: Reservoir, intake, penstock, powerhouse, tailrace- Basic idea of rainfall and water flow measurement, Introduction to terms: Notch, Weir, Flume (no technical detail).	4	2
	2.4	Practical : Measurement of Water Flow Using V-Notch Weir	8	2
3		**Components and Working of Hydropower Plants**	**20 hrs**	
	3.1	Components of Hydropower Plants- Hydraulic Turbines: Types (Impulse and Reaction), Theory, and Operational Aspects, Turbine Selection and Efficiency Considerations	4	3
	3.2	Types of Generators: Synchronous and Induction, Transformers, Protection and Control Systems,	4	3
	3.3	Transmission and Distribution Systems, Supporting Infrastructure: Dam, Spillway, Surge Chambers, Penstock, Tailrace	4	3

	3.4	Practical: Identify and Label Components of a Mini Hydro Plant Model, Case Study Presentation on Indian Hydropower Stations	8	3
4	**Innovations and Modern Technologies in Hydropower**		**20 hrs**	
	4.1	Hydro Generators with Controlled Rotors, Variable Speed Hydro Power Generation	3	4
	4.2	Fish- Friendly Hydropower Technologies and Turbine Design	4	4
	4.3	Control Technologies : Passive, Active & Magneto-Rheological Techniques, Digitalization of Hydropower Plant Operations, Floating Solar-Hydro Hybrid Systems, Electric Energy Storage Integration- Hydropower in India	3	4
	4.4	Famous hydropower stations (Tehri, Bhakra Nangal, etc.) - Environmental Awareness: Importance of clean rivers, Eco-friendly and sustainable project planning.	4	4
	4.5	Practical: Demonstration of Electrical Safety Devices.	6	4
5	**Teacher specific content**			

<table>
<tr>
<td>Teaching and Learning Approach</td>
<td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td>
</tr>
<tr>
<td rowspan="2">Assessment Types</td>
<td>MODE OF ASSESSMENT</td>
</tr>
<tr>
<td>
A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
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Practical
<table>
<tr><td colspan="2">Total Mark: 15</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Involvement</td><td>5</td></tr>
<tr><td>Punctuality</td><td>5</td></tr>
<tr><td>Record/ Report</td><td>5</td></tr>
</table>
B. End Semester Evaluation (ESE)
Theory
<table>
<tr><td colspan="3">Total mark: 50</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 15 out of 17</td></tr>
</table>
</td>
</tr>
</table>

Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Singal, S. K., Saini, R. P., & Sharma, M. P. (n.d.). *Renewable energy sources: Hydropower*.
2. Boyle, G. (n.d.). *Renewable energy: Power for a sustainable future*. Oxford University Press.
3. Nelson, V. C., & Starcher, K. L. (n.d.). *Introduction to renewable energy*.
4. Gulliver, J. S., & Arndt, R. E. A. (n.d.). *Hydropower engineering handbook*.

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<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Biomass Conversion System</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG4SDCREM202</td></tr>
<tr><td>Course Level</td><td colspan="5">200</td></tr>
<tr><td>Course Summary</td><td colspan="5">Biomass Energy is a crucial part of sustainable and renewable energy systems, which includes technical, environmental, and practical aspects.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the types, properties, processing, and applications of biomass as a renewable energy source, and assess its potential in sustainable energy systems.	U, A, An	1
2	Understand and analyze the physical, thermal, and chemical properties of biomass to evaluate its suitability for various renewable energy applications.	U,A,An	2
3	Understand biological biomass conversion processes such as biomethanation and fermentation, and analyze biogas plant types, their socio-economic viability, and environmental impacts.	U , A, An	3
4	Understand and analyze chemical conversion processes such as hydrolysis, hydrogenation, solvent extraction, and synthesis of biofuels and chemicals from biomass. To identify the biomass resources and study biogas generation	U, A, An,C	3,4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX*

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	0	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	0	0
CO 3	0	0	3	0	0	0	0	0	0	0
CO 4	0	0	3	2	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Biomass 12 hrs**		
	1.1	Types of biomass, advantages and disadvantages in use of biomass as energy,	3	1
	1.2	Physical and thermal properties of biomass, chemical composition.	3	1
	1.3	Sources of biomass Size reduction, Briquetting, Drying, Storage and handling of biomass.	4	1
	1.4	Current biomass applications and trends.	2	1
2		**Thermo chemical conversion**: **13 hrs**		
	2.1	Effect of pressure, temperature, steam and oxygen.	3	2
	2.2	Combustion,Incineration,gasification, pyrolysis, hydrothermal liquefaction.	3	2
	2.3	Thermochemical conversion of lignocellulosic biomass	3	2
	2.4	Fixed and fluidized bed Gasifiers- Partial gasification of biomass by CFB.	4	2

3		**Biological conversion 15 hrs**		
	3.1	Biodegradation - Biochemistry and process parameters of biomethanation -. Biomethanation Process -	5	3
	3.2	**Types of biogas plants**-continuous type , dome type,floating drum type -KVIC, fixed dome type -Janata model. Advantages and Disadvantages.	6	3
	3.3	Economics of biogas plants with their environmental and social impacts - Bioconversion of substrates into alcohol - Methanol & ethanol Production.	4	3

4	**Chemical conversion**: 35 hrs			
	4.1	**Chemical conversion**: Hydrolysis & hydrogenation- Study of Solvent extraction of hydrocarbons - Biocrude and biodiesel - Chemicals from biomass.	5	4
	4.2	**Practicals:** 1.Identification of different biomass sources in environment, Estimation of fixed carbon of the given biomass	6	4
		2.Estimation of moisture and ash content for different types of biomass, Estimation of total solid and volatile solid in different types of biomass	6	4
		3. Understand biomass to biogas pathway-Slurry mixing, gas collection dome	6	
		4.Identify and classify local biomass sources-Collect samples (paddy husk, banana waste)	6	4
		5.Waste-to-energy cycle overview	6	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience
Assessment Types	**MODE OF ASSESSMENT** **A . Continuous Comprehensive Assessment (CCA)** **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Kothari, D. P., Singal, K. C., & Ranjan, R. (n.d.). *Renewable energy sources and emerging technologies*.
2. Rai, G. D. (2011). *Non-conventional energy sources* (5th ed.). Khanna Publishers.

Suggested Readings

1. Khan, B. H. (n.d.). *Biomass and bioenergy*. Tata McGraw-Hill.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme					
Course Name	Solar Heating and Cooling Techniques				
Type of Course	MPC				
Course Code	MG4MPCREM200				
Course Level	200				
Course Summary	Students will understand the principles and technologies of solar heating and cooling systems. They will be able to design and evaluate efficient solar thermal applications for sustainable energy use.				
Semester	4	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamentals of solar radiation and evaluate the performance of various solar thermal collectors.	U, E	1, 2
2	Design and analyze solar water heating systems for both domestic and industrial applications.	A, An, C	2, 3, 10
3	Explain and assess solar space heating and cooling techniques, including passive and active systems	U, E	1, 2, 6
4	Evaluate the techno-economic aspects, policies, and lifecycle of solar thermal applications in different sectors.	E, An	1, 7 ,8
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	2	3	0	0	0	0	0	0	2
CO 3	3	2	0	0	0	2	0	0	0	0
CO 4	3	0	0	0	0	0	2	2	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Basics of Solar Thermal Systems** **20 hrs**		
	1.1	Solar radiation fundamentals: solar angles, radiation components	4	1
	1.2	Solar thermal collectors: flat plate, evacuated tube collectors	4	1
	1.3	Heat transfer fluids and materials - Efficiency and performance evaluation of collectors.	4	1
	1.4	Practical: Testing efficiency of a flat plate collector	8	1
2		**Solar Water Heating Systems** **20 hrs**		
	2.1	Domestic and industrial water heating	3	2
	2.2	Active vs. passive systems - System components: storage tanks, pumps, heat exchangers	4	2
	2.3	Design, sizing, and performance analysis	5	2
	2.4	Practical : Design and simulation of a solar water heating system.	8	2
3		**Solar Space Heating and Cooling Techniques** **20 hrs**		
	3.1	Passive heating techniques: thermal mass, insulation, glazing	3	3
	3.2	Active space heating: forced air and hydronic systems	2	3
	3.3	Solar-assisted cooling systems: absorption cooling, desiccant cooling -Building-integrated solar thermal systems.	7	3
	3.4	Practical: Case study on solar cooling system or passive heating design.	8	3
		Applications, Economics, and Policies **15 hrs**		

4	4.1	Applications in buildings, industries, and agriculture	3	4
	4.2	Economic analysis: cost–benefit, payback period, incentives	3	4
	4.3	National and international solar thermal policies- Maintenance, durability, and lifecycle assessment.	3	4
	4.4	Practical : Economic analysis of a solar thermal project	6	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Duffie, J. A., & Beckman, W. A. (2013). *Solar engineering of thermal processes* (4th ed.). Wiley.
2. Sukhatme, S. P. (2008). *Solar energy: Principles of thermal collection and storage* (3rd ed.). Tata McGraw-Hill.
3. Garg, H. P., & Prakash, J. (n.d.). *Solar energy: Fundamentals and applications*. Tata McGraw-Hill.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science
Programme	B.Voc . (Honours) Renewable Energy Management
Course Name	Data analytic and Computational Techniques
Type of Course	SEC
Course Code	MG4SECREM200
Course Level	**200**
Course Summary	Data analytics and computational techniques are relevant across a wide range of industries, contributing to improved decision-making,operational efficiency and innovation. As technology continues to advance,the importance of data analytics is likely to grow,shaping the way businesses and organizations operate in the future.

Semester	**4**	**Credits**		**3**	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	**0**	**0**	**45 hours**
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Represent and interpret raw data using appropriate classification, tabulation methods, and graphical tools such as bar diagrams, pie charts, and frequency graphs.	U, A, An, E	1, 2
2	Compute and interpret various descriptive statistical measures such as measures of central tendency and dispersion including mean, median, mode, percentiles, and standard deviation.	U, A, An ,E	2
3	Apply fundamental concepts of probability, including events, theorems, and conditional probability, to solve real-life and theoretical problems.	U , A, An, E	1, 2,3,10
4	Experiencing different graphing tools in mathematics	S	2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX*

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	0	0	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	0	0
CO 3	2	3	2	0	0	0	0	0	0	1
CO4	0	3	0	0	0	0	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Data representation**		**15 hrs**	
	1.1	Raw data, classification and tabulation of data, frequency tables, contingency table;	7	1
	1.2	Diagrams - Bar diagrams, sub divided bar diagrams, Pie diagrams, Graphs - frequency polygon , frequency curve, ogives.	8	1,4
2	**Descriptive statistics**		**15 hrs**	
	2.1	Percentiles, deciles, quartiles, arithmetic mean, median, mode, geometric mean and harmonic mean.	8	2
	2.2	range,Mean deviation, variance, standard deviation, quartile deviation,	7	2
3	**Probability**		**15 hrs**	
	3.1	Random experiment, sample space. definitions of probability,	4	3
	3.2	Events, types of events, independence of events,	4	3
	3.3	Addition theorem, conditional probability,	3	3
	3.4	Multiplication theorem, Baye’s theorem.	4	3
4	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Utilize Combination of lectures and discussions to facilitate comprehensive learning experience.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table>
B. End Semester Evaluation (ESE)
Theory
<table>
<tr><td colspan="3">Total mark: 50</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 10 out of 12</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 4 out of 6</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table>
Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

1. Gupta, S. C., & Kapoor, V. K. (n.d.). *Fundamentals of mathematical statistics*.
2. Spiegel, M. (n.d.). *Probability and statistics* (Schaum's Outline Series).
3. Mendenhall, W. (n.d.). *Introduction to probability and statistics*.
4. Navidi, W. (n.d.). *Statistics for engineers and scientists*.
5. NPTEL. (n.d.). *Probability and statistics* [IIT Kanpur or IIT Madras].

Suggested Readings

1. Gupta, S. C. (n.d.). *Fundamentals of statistics*. Himalaya Publishing House.
2. Gupta, S. P. (n.d.). *Statistical methods*. Sultan Chand & Sons.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Environmental Education				
Type of Course	VAC				
Course Code	MG4VACREM200				
Course Level	200				
Course Summary	This course offers an overview of environmental education, focusing on key issues like pollution, biodiversity loss, and sustainable resource management. It covers environmental laws, policies, and movements in India while highlighting effective teaching strategies. Students are equipped to promote environmental awareness and sustainability through education.				
Semester	4	**Credits**		3	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	0	0	45 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the objectives, nature, and characteristics of environmental education and recognize the causes and socio-economic impacts of environmental degradation.	U,K	1,3,6,7
2	Identify different types of environmental pollution, their causes, effects, and mitigation strategies, along with understanding climate change phenomena	U,,An	2,3,6,7
3	Analyze major environmental movements and legal-political efforts in India and globally aimed at environmental protection.	R,An	1,4,5,6
4	Develop and apply appropriate teaching methods and assessment tools to promote environmental awareness in learners	A,S	4,5,8,10
**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap*			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	3	0	0	3	2	0	0	0
CO 2	0	3	2	0	0	3	2	0	0	0
CO 3	3	0	0	2	2	3	0	0	0	0
CO 4	0	0	0	3	2	0	0	1	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Environmental Education and Degradation 15 hrs**		
	1.1	Objectives, and Nature of Environmental Education, Characteristics of Environmental Education	3	1
	1.2	Environmental education at Primary,Secondary and Higher Education level.	4	1
	1.3	Factors of degradation of environment – adverse socio – economic impacts of degradation of environment, Impact of Science and technology on environment degradation of resources	4	1
	1.4	National resource center for environmental education.	4	1
2		**Environmental Pollution and Consequence 12hrs**		
	2.1	Environmental Pollution- Types of Environmental Pollution- Causes of Environmental Pollution- Effects of Environmental Pollution	4	2
	2.2	Green house effect- Enhanced Greenhouse Effect-Adaptation Strategies	2	2
	2.3	Ozone layer depletion- Causes of Ozone Layer Depletion- Consequences of Ozone Layer Depletion	2	2
	2.4	Factors responsible for flora and fauna extinction – Causes for forest fire- measures of prevention.	4	2
3		**Environmental Policies and Movements in India 18 hrs**		
	3.1	Environmental Movements for the Protection of India-Chipko Movement (1973),Silent Valley Movement (1978),Appiko Movement (1983)	3	3
	3.2	Environmental Policies in India-National Environment Policy,National Conservation Strategy and Policy Statement on Environment and Development	4	3
	3.3	Environmental Laws in India-Environment (Protection) Act,National Green Tribunal (NGT) Act	4	3
	3.4	International Efforts for Environmental Protection, Paris Agreement (2015) – The Rio Summit 1992 – Kyoto conference	4	4
	3.5	Global- Renewable Energy Initiatives	3	4
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 10 out of 12
Part B	5 mark	Answer any 4 out of 6
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Sharma, R. A. (2008). *Environmental education*. Meerut: R. Lall Books Depot.
2. Reddy, P. K., & Reddy, N. D. (2001). *Environmental education*. Hyderabad: Neelkamal Publications.
3. Singh, Y. K. (2009). *Teaching of environmental science*. New Delhi: APH Publishing Corporation.

Suggested Readings

1. Paulford, I., & Flowers, H. (2006). *Environmental chemistry at a glance*. Blackwell.
2. Harrison, R. M. (1993). *Pollution: Causes, effects and control*. Royal Society of Chemistry.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Internship				
Type of Course	INT				
Course Code	MG4INTREM200				
Course Level	**200**				
Course Summary	The Internship / On-the-Job Training (OJT) in **Renewable Energy Management** aims to provide students with practical exposure and hands-on experience in the renewable energy sector. It bridges the gap between theoretical knowledge and real-world application by placing students in industries, energy companies, or organizations engaged in solar, wind, biomass, energy auditing, or sustainable energy practices. During the internship, students will observe, participate in, and contribute to ongoing projects and daily operations. They will work under professional supervision, gaining insights into renewable energy technologies, installation, maintenance, monitoring, project planning, and energy management systems.				
Semester	4	**Credits**		2	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		0	0	2	20 days
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No:	Expected Course Outcome	Learning Domains	PO No:
1	Demonstrate practical understanding of operational aspects in their domain by engaging in real-world industry settings.	Ap	1,3,6,10
2	Apply academic knowledge and skills to identify and solve industry-relevant problems.	A	1,2,3,10
3	Exhibit professional competencies including effective communication, teamwork, time management, and ethical responsibility.	S	4,5,8,9
4	Develop an understanding of workplace practices, expectations, and challenges.	U	1,6,10
5	Reflect critically on their internship experience to identify personal strengths, growth areas, and career aspirations.	E	1,6,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	2	0	0	2	0	0	0	3
CO 2	3	2	2	0	0	0	0	0	0	3
CO 3	0	0	0	2	3	0	0	2	2	0
CO 4	2	0	0	0	0	2	0	0	0	3
CO 5	2	0	0	0	0	2	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT		
	A	**Internal Evaluation**	
		Components	**Marks**
		Feedback from the hosting organization	5
		Internal Supervisor feedback	10
		Total	**15**
	B	**External Evaluation**	
		Components	**Marks**
		Presentation	10
		Report	10
		Viva Voce	15
		Total	**35**

SEMESTER 5

	# Mahatma Gandhi University Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Tidal, nuclear and geothermal Energy systems				
Type of Course	SDC				
Course Code	MG5SDCREM300				
Course Level	**300**				
Course Summary	This course provides an in-depth understanding of alternative renewable energy sources such as tidal power, ocean thermal energy, nuclear fusion, and geothermal energy. It covers the working principles, components, operation methods, and site requirements of each system, along with their advantages, limitations, and applications. A comparative analysis is included to evaluate the most suitable renewable energy option for Kerala, promoting region-specific energy planning and sustainability awareness.				
Semester	5	**Credits**		4	**Total Hours**
Course Details	**Learning** Approach	**Lecture**	**Practical**	**OJT**	
		4	0	0	60 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	To understand tidal power generation systems, and to analyze their advantages, limitations, and practical feasibility.	U,An	1,2
2	To acquire the ability to understand the principles and working of Ocean Thermal Energy Conversion systems.	U,E	2
3	To understand fundamentals of nuclear fusion, identify the requirements & confinement methods for fusion, and evaluate the working and feasibility of thermonuclear reactors.	U,E,Ap	1,2,6
4	To acquire an understanding of the nature and types of geothermal fields and resources.	U,E,I	2,6
5	To critically evaluate renewable energy systems based on their technical feasibility, environmental impact & geographic suitability, with a specific focus on their applicability in the context of Kerala.	E,I,Ap	1,2,6,7
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	0	0	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	0	0	0	0
CO 3	3	3	0	0	0	2	0	0	0	0
CO 4	0	0	1	0	0	2	0	0	0	0
CO 5	3	3	0	0	0	3	3	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Tidal Power 13 hrs**		
	1.1	Introduction, Basic Principle of Tidal Power, Components of Tidal Power Plants,	4	1
	1.2	Operation Methods of Utilization of Tidal Energy - Simple Single Basin Tidal System and Double Basin Tidal System	5	1
	1.3	Requirements, Storage, Advantages and Limitation of Tidal Power Generation.	4	1
2		**Ocean Thermal Energy Conversion 15 hrs**		
	2.1	Ocean Thermal Energy Conversion	4	2
	2.2	Methods of Ocean Thermal Electric Power Generation - Open Cycle OTEC System, Closed OTEC Cycle System	6	2
	2.3	Heat Exchangers, Bio-fouling, Site-Selection, Energy Utilization	5	2
3		**Nuclear power 16 hrs**		
	3.1	Introduction, The Basic: Nuclear Fusion and Reactions	4	3
	3.2	Requirements for Nuclear Fusion, Plasma Confinement - Magnetic-Confinement Fusion, Inertial-confinement Fusion,	6	3
	3.3	Working of a thermonuclear reactor, Advantages and disadvantages of Nuclear Fusion	6	3
4		**Geothermal Energy 16 hrs**		
	4.1	Geothermal field, Nature of Geothermal Fields, Geothermal Sources – Hydrothermal Resources	4	4
	4.2	Vapour Dominated Systems, Liquid-Dominated Systems, Geo-pressured Resources, Hot Dry Rock Resources, Magma Resources	7	4
	4.3	Advantages and Disadvantages of Geothermal Energy, Applications of Geothermal Energy	5	4
5		**Teacher specific content**		

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td>Assessment Types</td><td>MODE OF ASSESSMENT
A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 30</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>10</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table>
B. End Semester Evaluation (ESE)
Theory
<table>
<tr><td colspan="3">Total mark: 70</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 2 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 25 out of 27</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 5 out of 7</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table>
Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

1. Rao, S., & Parulekar, B. B. (n.d.). *Energy technology: Nonconventional, renewable & conventional*. Khanna Publishers. ISBN 81-7409-040-1.
2. Rai, G. D. (n.d.). *Solar energy utilization*. Khanna Publishers. ISBN 81-7409-073-8.
3. Domkundwar. (n.d.). *Nonconventional energy sources*. Dhanpat Rai & Co.

Mahatma Gandhi University
Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Energy storage systems				
Type of Course	SDE				
Course Code	MG5SDEREM300				
Course Level	300				
Course Summary	This course introduces various energy storage systems including mechanical, electrical, chemical, thermal, and electromagnetic methods. It covers their working principles, implementation, and applications in areas like transportation and power systems..				
Semester	5	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the principles and applications of mechanical and electrical energy storage systems.	U	1, 2
2	Explain advanced chemical and biological energy storage methods, including hydrogen-based systems.	U	2, 6
3	Analyze thermal energy storage techniques using sensible and latent heat with practical applications	An	2, 7
4	Describe electromagnetic storage technologies like SMES and supercapacitors, including their working and use cases.	U	2, 3
5	Perform practical experiments to evaluate the performance of various energy storage systems.	E	1, 10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	2	0	0	0	2	0	0	0	0
CO 3	0	2	0	0	0	0	2	0	0	0
CO 4	0	2	2	0	0	0	0	0	0	0
CO 5	2	0	0	0	0	0	0	0	0	2

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Mechanical and Electrical**	**22 hrs**	
	1.1	Mechanical energy storage - pumped hydroelectric, compressed air, flywheel	10	1
	1.2	Electrical storage - the lead acid battery.	4	1
	1.3	Practical: Charging and discharging characteristics of a lead acid battery	8	5
2		**Advanced energy storage systems**	**20 hrs**	
	2.1	Chemical storage - storage via hydrogen, ammonia, reversible chemical reactions.	5	2
	2.2	Hydrogen storage, hydrogen as an alternative fuel for motor vehicles	5	2
	2.3	Biological storage.	3	2
	2.4	Practical : Hydrogen Generation via Electrolysis	7	5
3		**Thermal energy storage**	**18 hrs**	
	3.1	Sensible heat & latent heat systems	3	3
	3.2	Sensible heat & latent heat systems-implementation,	4	3
	3.3	working and applications.	4	5
	3.4	Practical : Latent Heat Storage Using Phase Change Material (PCM)	7	5
4		**Electromagnetic energy storage**	**15 hrs**	
	4.1	SMES, Super capacitors	5	4
	4.2	Basic principles and applications.	2	5
	4.3	Practical : Charge and discharge characteristics of a supercapacitors	8	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience
Assessment Types	**A. Continuous Comprehensive Assessment (CCA)** **Theory** **Total Mark: 25** **Assessment methods** Assignment: 10 Seminar/ Quiz/ Group Discussion: 5 Test: 10 **Practical** **Total Mark: 15** **Assessment methods** Involvement: 5 Punctuality: 5 Record: 5 **B. End Semester Evaluation (ESE)** **Theory** **Total mark: 50** **Assessment methods: Written Exam** **Duration of Examination: 1.5 hrs** **Pattern of Examination: Non-MCQ** Part A – 1 mark – Answer any 15 out of 17 Part B – 5 mark – Answer any 3 out of 5 Part C – 10 mark – Answer any 2 out of 4 Part A can be objective type, fill in the blanks, multiple choice etc.

A. Continuous Comprehensive Assessment (CCA) – Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE) – Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

	Practical **Total mark: 35** **Duration of Examination: 2 hrs** **Assessment methods** Theory/ Procedure — 10 Skill and Performance — 10 Calculation and Result — 10 Viva — 5

References

1. Rai, G. D. (n.d.). *Non-conventional energy sources*. Khanna Publishers.
2. Huggins, R. A. (n.d.). *Energy storage: Fundamentals, materials and applications*.

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<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Green Hydrogen Manufacturing and Applications</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDE</td></tr>
<tr><td>Course Code</td><td colspan="5">MG5SDEREM301</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces green hydrogen, its production, storage, and applications in energy, industry, and transport. It covers clean technologies for a sustainable future.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the significance of hydrogen as an energy carrier by analyzing its types, properties, and comparison with conventional fuels.	U, An	1, 2
2	Explain and compare various green hydrogen production technologies including electrolysis methods and their integration with renewable energy sources.	U, An	1, 2, 3
3	Explain and compare various green hydrogen production technologies including electrolysis methods and their integration with renewable energy sources.	U, A	1, 2, 3
4	Identify and evaluate diverse applications of green hydrogen in power, industry, and mobility sectors, including fuel cell technologies.	E, A, C	2, 6, 10
5	Perform basic experiments and demonstrations related to hydrogen generation, storage, and use, and explain the outcomes.	A, U, S	2, 3, 4
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	2	3	2	0	0	0	0	0	0	0
CO 3	2	3	2	0	0	0	0	0	0	0
CO 4	0	3	0	0	0	2	0	0	0	2
CO 5	0	3	3	2	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Hydrogen as an Energy carrier**	**14 hrs**	
	1.1	History and significance of hydrogen energy, Types of hydrogen (gray, blue, green, pink, etc.)	3	1
	1.2	Thermodynamic and physicochemical properties, Comparison with other fuels (energy density, emissions)	3	1
	1.3	Practical : Demonstration of hydrogen generation via metal-acid reaction.	8	5
2		**Green Hydrogen Production Technologies**	**17 hrs**	
	2.1	Electrolysis principles (Alkaline Electrolysis, PEM (Proton Exchange Membrane) Electrolysis, Solid Oxide Electrolysis (SOEC), Water sources for electrolysis:	3	2
	2.2	Freshwater, seawater, Renewable energy integration (solar PV, wind, hydro)	3	2
	2.3	Overview of photoelectron chemical and thermochemical methods (introductory level).	3	2
	2.4	Practical :Water source comparison– Compare electrolysis efficiency using freshwater vs. tap water (discussion on seawater challenges).	8	5
3		**Hydrogen Storage and Transportation**	**18 hrs**	
	3.1	Physical storage methods	3	3
	3.2	Compressed, liquefied, Material-based storage	4	3
	3.3	Pipelines, cylinders, tankers, Safety regulations and standards (ISO, BIS).	3	3
	3.4	Practical : Metal hydride simulation model– Use visuals or demo kits showing absorption and release of hydrogen in metal hydride canisters.	8	5
4		**Applications of Green Hydrogen**	**26 hrs**	
	4.1	Power generation and grid balancing	5	4
	4.2	Industrial applications (ammonia production, steel, refineries),	3	4
	4.3	Fuel cells: types and applications (PEMFC, SOFC, AFC), Mobility	4	4

	4.4	hydrogen vehicles (FCEVs), infrastructure, Emerging technologies	4	4
	4.5	synthetic fuels, hydrogen blending in natural gas.	4	4
	4.6	Practical : Video + Discussion: Hydrogen Use in Industry	6	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

	B. End Semester Evaluation (ESE) **Theory** **Total mark: 50** **Assessment methods: Written Exam** **Duration of Examination: 1.5 hrs** **Pattern of Examination: Non-MCQ** Part A | 1 mark | Answer any 15 out of 17 Part B | 5 mark | Answer any 3 out of 5 Part C | 10 mark | Answer any 2 out of 4 Part A can be objective type, fill in the blanks, multiple choice etc. **Practical** **Total mark: 35** **Duration of Examination: 2 hrs** **Assessment methods** Theory/ Procedure/ Understanding | 10 Skill and Performance/ Data collection | 10 Calculation/ Analysis and Result | 10 Viva | 5

References

1. Sorensen, B. (2005). *Hydrogen and fuel cells: Emerging technologies and applications* (Illustrated ed.). Elsevier Academic Press.
2. Rand, D. A. J., & Dell, R. (2008). *Hydrogen energy: Challenges and prospects*. The Royal Society of Chemistry.

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Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Grid Integration and Smart grid technologies				
Type of Course	SDC				
Course Code	MG5SDCREM301				
Course Level	**300**				
Course Summary	This course provides a comprehensive understanding of the integration of distributed renewable energy systems into the electric grid and introduces smart grid concepts that enhance the efficiency, reliability, and sustainability of modern power systems. Topics include grid code compliance, power quality, system stability, smart metering, automation, communication technologies, demand response, and cybersecurity in the context of smart grids.				
Semester	5	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	NIL				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the structure and functioning of power generation, transmission, distribution, and substations.	U	1
2	Describe the components and operation of rooftop solar PV power plants and assess their performance.	U	1,2
3	Compare traditional and smart grids in terms of technology, efficiency, and communication systems.	A	1,2,3
4	Explain the operation and benefits of smart meters, AMR, AMI, and IEDs in smart substations. Analyze power quality issues and grid integration challenges for distributed renewable systems.	U,A	1,2,3
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	2	0	0	0	0	0	0	0
CO 4	2	3	2	0	0	0	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basics of Power Grid**		**12hrs**	
	1.1	Generation, transmission and distribution,	2	1
	1.2	Substation: basic layout, substation	2	1
	1.3	Components: protection and metering equipments,	2	1
	1.4	Major faults, earthing-synchronisation.	3	1
	1.5	Practical :Study different components of grid and smart grid.	3	1,3
2	**Rooftop Solar PV Power Plant**		**18 hrs**	
	2.1	Working principles-System components and operating principles of a Rooftop Solar PV Power Plant	3	2
	2.2	Metering arrangement for Rooftop Solar-Policy.	3	2
	2.3	Single line diagram of a rooftop solar PV power plant.	3	2
	2.4	Metering system-import and export of energy-inverterOperation-including anti-islanding functionality.	3	2
	2.5	Power quality of rooftop PV power Plant: Harmonics, current, voltage-power factor.	3	2
	2.6	Practical :Familiarize with key terminology and metrics used in power quality assessment	3	1,3
	Introduction to smart Grid		**22 hrs**	
	3.1	Evolution of electric grid, Definitions, Need for smart grid.	3	3
	3.2	Smart grid drivers, Functions of smart grid, Opportunities and barriers of smart grid.	3	3

	3.3	Difference between conventional grid and smart grid.	2	3
	3.4	Information and Communication Technology in Smart Grid.	2	3
	3.5	Practical :Study the role and functioning of automation systems in modern power distribution and substations..	12	1,3
4	**Introduction to smart meters**		**23 hrs**	
	4.1	Electricity tariff, Real Time Pricing- Automatic Meter Reading (AMR) - System, Services and Functions, Components of AMR Systems.	3	4
	4.2	Advanced Metering Infrastructure (AMI). Intelligent Electronic Devices (IED) and their application for monitoring & protection:	3	4
	4.3	Digital Fault Recorder (DFR), Digital Protective Relay (DPR),	2	4
	4.4	Circuit Breaker Monitor (CBM), Smart substations, Substation automation.	3	4
	4.5	Practical: Examine the application of Information and Communication Technologies (ICT)in smart grid systems.	12	1,3
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Use of CT tools in conjunction with traditional classroom teaching method,interactive Sessions,Class Discussions,Lab Exercises
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Mehta, V. K., & Mehta, R. (n.d.). *Principles of power system*. S. Chand Publications.
2. Jamil, M., Rizwan, M., & Kothari, D. P. (n.d.). *Grid integration of solar photovoltaic systems*.
3. Borlase, S. (2013). *Smart grids: Infrastructure, technology and solutions*. CRC Press.
4. Solanki, C. S. (n.d.). *Solar photovoltaics: Fundamentals, technologies and applications*. PHI Learning.

Suggested Readings

1. Ekanayake, J., et al. (n.d.). *Smart grid: Technology and applications*. Wiley.
2. McDonald, J. D. (n.d.). *Electric power substations engineering*. CRC Press.
3. Heber, G., & Fuchs, H. (n.d.). *Smart metering design and applications*. Springer.

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Faculty/ Discipline	Science				
Programme					
Course Name	Novel renewable energy sources				
Type of Course	MPC				
Course Code	MG5MPCREM300				
Course Level	300				
Course Summary	This course includes novel renewable energy technologies such as advanced hydrogen production, innovative fuel cell systems, and modern geothermal and ocean energy applications. It also covers recent advancements in magnetohydrodynamic (MHD) energy conversion and highlights emerging trends in renewable energy, supporting the transition to cleaner and more efficient power production.				
Semester	5	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT***	
		4	0	0	60
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To explain the properties, production methods, storage, and applications of hydrogen energy	U, A	1, 2,3,7
2	To describe the components, working principles, and types of fuel cells, and compare them with conventional batteries	U, K	1,2,3,7
3	To identify geothermal and ocean energy resources, describe their conversion technologies, and discuss their advantages and applications	U, An	1,2,3,7
4	To outline the principles and types of magnetohydrodynamic (MHD) energy conversion systems and explain their benefits and applications	U, A, An	1,2,3

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10
CO 1	1	2	4	0	0	0	3	0	0	0
CO 2	1	3	3	0	0	0	3	0	0	0
CO 3	1	3	3	0	0	0	3	0	0	0
CO 4	1	3	3	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Hydrogen energy**		**15 Hrs**	
	1.1	Introduction, Properties of hydrogen,	2	1
	1.2	Hydrogen production – Electrolysis, Iodine-sulfur cycle,	3	1
	1.3	Coal gasification, Bio photolysis,	2	1
	1.4	Photo electrolysis	2	1
	1.5	Hydrogen storage	2	1
	1.6	Hydrogen transportation	2	1
	1.7	Applications	2	1
2	**Fuel cell systems**		**15 hrs**	
	2.1	Introduction - Components, Principle of working	3	2
	2.2	Battery versus fuel cell	2	2
	2.3	Classification of fuel cells – Types of fuel cells: Alkaline fuel cell	2	2
	2.4	Solid oxide fuel cell, Phosphoric acid fuel cell,	2	2
	2.5	Molten carbonate fuel cell,	2	2
	2.6	Proton exchange membrane fuel cell	2	2

	2.7	Application of fuel cells	2	2

3	**Geothermal and Ocean energy**		**15Hrs**	
	3.1	Geothermal fields, Geothermal sources	2	3
	3.2	Geothermal energy powerplant,	2	3
	3.3	Advantages and disadvantages, Applications of geothermal energy.	3	3
	3.4	Ocean energy resources	2	3
	3.5	Ocean thermal energy conversion	2	3
	3.6	Tidal energy conversion	2	3
	3.7	Wave energy conversion	2	3
4	**Magneto hydrodynamic (MHD) energy conversion**		**15Hrs**	
	4.1	Principles of MHD power generation	2	4
	4.2	MHD power generator,	2	4
	4.3	Classification – Open cycle systems, Closed cycle systems	4	4
	4.4	Advantages of MHD systems	1	4
	4.5	Gas conductivity	2	4
	4.6	Types of ionization	2	4
	4.7	Super conducting magnetic energy storage (SMES) systems	2	4
5	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Presentations, Discussions.</td></tr>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 30</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>10</td></tr>
<tr><td>Test</td><td>10</td></tr>
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<tr><td>B. End Semester Evaluation (ESE)
Theory
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<tr><td colspan="3">Total mark: 70</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 2 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 25 out of 27</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 5 out of 7</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table></td></tr>
<tr><td></td><td>Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

1. Rai, G. D. (2011). *Non-conventional energy sources* (5th ed.). Khanna Publishers.
2. Kordesch, K., & Simader, G. (1996). *Fuel cells and their applications* (1st ed.). Wiley-VCH.

Suggested Readings

1. Rajput, R. K. (2012). *Non-conventional energy sources and utilization (energy engineering)* (1st ed.). S. Chand & Company Ltd.
2. Kordesch, K., & Simader, G. (1996). *Fuel cells and their applications* (1st ed.). Wiley-VCH.
   (Also listed in References)
3. Sørensen, B. (2005). *Hydrogen and fuel cells: Emerging technologies and applications* (Illustrated ed.). Elsevier Academic Press.

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<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Softwares for renewable energy system design</td></tr>
<tr><td>Type of Course</td><td colspan="5">SEC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG5SECREM300</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces students to essential software tools used in the design and simulation of renewable energy systems. It covers the basics of AutoCAD for drafting, PVsyst for solar system analysis, HOMER for hybrid energy modeling, and RETScreen for energy project feasibility</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practicum/Practical</td><td>OJT</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>60 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">NIL</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the interface, tools, and functionalities of AutoCAD for technical drawing and design.	U	2, 10
2	Apply AutoCAD tools to create 2D building layouts and annotate solar PV components.	A	2, 3, 10
3	Develop detailed rooftop solar PV system layouts including module placement, cabling, and SLD using AutoCAD.	C	2, 3
4	Utilize advanced AutoCAD features such as 3D modeling and parametric constraints for customized designs	An	1, 2, 10
5	Use PVSol software for simulating and designing stand-alone and grid-connected solar PV systems.	A	2, 4, 10
6	Design PV systems using SolarEdge software and generate performance reports with system details.	C	2, 4, 10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	3	0	0	0	0	0	0	0	2
CO 2	0	3	2	0	0	0	0	0	0	2
CO 3	0	3	3	0	0	0	0	0	0	0
CO 4	2	3	0	0	0	0	0	0	0	2
CO 5	0	3	0	2	0	0	0	0	0	2
C0 6	0	3	0	2	0	0	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to autocad 20 hrs**		
	1.1	Overview of autocad software, history and versions, drawing & editing tools, precision drawing techniques, advanced editing tools	6	1
	1.2	Practical:Interface Overview: Ribbon, Menus, Toolbars -Understanding the workspace-Basic Drawing Tools :Line, Circle, Arc, Rectangle, Polygon-Polyline vs Line-Ellipse, Spline-Using Object Snaps (OSNAP)	3	2
	1.3	Modifying Tools: Move, Copy, Rotate-Mirror, Offset-Trim, Extend-Scale, Stretch-Fillet, Chamfer-Precision Drawing and Editing: Grid, Snap, Ortho mode-Polar Tracking	4	2
	1.4	Construction lines and Ray-Advanced Drawing Tools: Multi Line and Multiline Styles-Region and Boundary-Hatch and Gradient-Divide and Measure-Annotation and Dimensioning: Text: Single-line and Multiline - Text Style	3	3
	1.5	Dimensioning types: linear, aligned, radial, angular - Layouts and Printing: Model Space vs Paper Space-Creating Layouts and Viewports-Title Blocks and Borders.	4	3
2		**Advanced techniques & Solar PV system design using autocad 20 hrs**		
	2.1	Practical drawing of building plans using autocad, draft solar drawing using autocad	3	2
	2.2	Drawing techniques, 3D modelling, parametric constraints, customization & automation	3	4
	2.3	Practical: Introduction to Solar PV Systems :Basics of solar energy and PV technology-Types of solar PV systems: On-grid, Off-grid, Hybrid-Key components	3	2
	2.4	Solar panels, inverters, batteries, charge controllers, etc-Overview of system design and layout requirements-Drawing Solar PV System Layouts: Rooftop layout and solar panel arrangement	3	3

	2.5	String sizing and module interconnections-DC cabling layout-AC cabling and switchgear layout	4	3
	2.6	Single Line Diagram (SLD) and Wiring Diagrams: Creating SLD for on-grid and off-grid PV systems	4	3
3	**PV Sol and Solar Edge fundamentals**		**20 hrs**	
	3.1	PV Sol components. Quick guide - working on projects, operating instructions & workflow.user interface, menu, speed button bar, load & save file, simulation, Quick design- stand- alone system, grid connected systems	3	5
	3.3	Inverter- grid connected & stand alone systems. SolarEdge- Introduction, project designing -choosing a location, defining modules & orientation, generating system report	2	5
	3.4	Practical: Hands - on - training in PVSol, Hands - on - training in Solar edge	15	6
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Practical**

Total Mark: 25	
Assessment methods	
Involvement	10
Punctuality	10
Record	5

B. End Semester Evaluation (ESE)

Practical

Total mark: 50	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Flow chart/ Demonstration	15
Skill and Performance	15
Result/ Output	10
Viva	10

References

1. Okorie, J. (n.d.). *Be a professional AutoCAD designer*.
2. CADArtifex, Dogra, S., & Willis, J. (n.d.). *A power guide for beginners and intermediate users*.
3. Gill, P. S. (n.d.). *Learning AutoCAD*. S. K. Kataria & Sons. ISBN 9789350145777.
4. Dr. Valentin Energie Software GmbH. (n.d.). *PVs*ol Pro version 5.5: Design & simulation PV system manual*.
5. SolarEdge. (n.d.). *Site designer* (Version 2.3).

	Mahatma Gandhi University Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Industrial Health and Safety				
Type of Course	VAC				
Course Code	MG5VACREM300				
Course Level	**300**				
Course Summary	The course emphasizes Health risks, hazard recognition, and safety in renewable energy work environments.Safe design and operation of renewable energy infrastructure.EHS planning, audits, documentation, and training strategies.				
Semester	5	**Credits**		3	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	0	0	45 hours
Pre-requisites, if any	NIL				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the need for developing Environment, Health, and Safety (EHS) systems in Industry	U, An	1, 2, 6,7
2	Implement safety practices to ensure worker safety at renewable energy sites.	U, E	1, 2, 6, 7
3	Describe the key components of an EHS policy and the need for documentation in RE projects.	U, S	2,3, 7, 10
4	Conduct basic EHS audits and risk assessments for renewable energy systems.	An, A,S	2, 3, 6
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

CO-PO ARTICULATION MATRIX*

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	2	1	0	0	0
CO 2	2	3	0	0	0	2	1	0	0	0
CO 3	0	2	3	0	0	0	2	0	0	1
CO 4	0	3	2	0	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Environment, Health & Safety**		**20hrs**	
	1.1	Importance of Environment, Health & Safety (EHS) in Industry	5	1
	1.2	Environmental Laws-Indian Acts, Regulations, and Codes of Practice	5	1
	1.3	International initiatives and national regulations relevant to renewable energy sites - OSHA, ILO, MNRE guidelines	5	1
	1.4	Categories of workplace health hazards: physical (noise, radiation), chemical, ergonomic and biological.	5	1
2	**Workplace and System Safety for Renewable Installations**		**10hrs**	
	2.1	Safe layout of renewable energy sites (rooftop solar, wind farms,biomas plants)	3	2
	2.2	Importance of ventilation, HVAC in control rooms and battery storage areas	3	2
	2.3	Electrical safety: grounding, isolation, maintenance in solar PV and wind turbine systems	4	2

Module	Units	Course description	Hrs	CO No.
3	**Risk Management and Environmental Safety Techniques**		**15hrs**	
	3.1	Health and Safety Policies and Documentation-10 essential safety documents	5	3
	3.2	Risk Assessment and Audits-Principles and process of hazard identification and risk evaluation, Safety inspections, audits, and their reporting procedures	5	4
	3.3	Incident Investigation, Quality and Environmental Management-Introduction to ISO 45001 and ISO 14001 standard	5	4
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Group Discussions

Assessment Types

MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 10 out of 12
Part B	5 mark	Answer any 4 out of 6
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Reese, C. D. (n.d.). *Occupational health and safety management: A practical approach*. CRC Press.
2. Friend, M. A., & Kohn, J. P. (n.d.). *Fundamentals of occupational safety and health*. Bernan Press.
3. Hughes, P., & Ferrett, E. (n.d.). *Introduction to health and safety at work*. Routledge.

Suggested Readings

1. International Labour Organization, & NIOSH. (n.d.). *Safety and health in the renewable energy industry: ILO/NIOSH guidelines*.
2. Lund, H. (n.d.). *Renewable energy systems: A smart energy systems approach to the choice and modeling of 100% renewable solutions*. Academic Press.

SEMESTER 6

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Power electronics</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDE</td></tr>
<tr><td>Course Code</td><td colspan="5">MG6SDEREM300</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive introduction to the principles and applications of power electronics. It focuses on the understanding and analysis of power semiconductor devices and their role in energy conversion. Students will explore the operation and characteristics of rectifiers, inverters, and AC voltage controllers. Through laboratory experiments, students will gain hands-on experience in implementing and analyzing power electronic systems.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Basics of electronics</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the operation of power semiconductor devices	U	1
2	Analyse the performance of power semiconductor diodes and transistors	An	1, 2
3	Analyse the working of thyristors	An	1, 2
4	Evaluate the performance of rectifiers, choppers, inverters, and AC voltage controllers	E	2
5	Design power electronic converters for various renewable energy applications	A	2, 7
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	0	0	0	0	0	0	0	0	0
CO 2	2	3	0	0	0	0	0	0	0	0
CO 3	2	3	0	0	0	0	0	0	0	0
CO 4	0	3	0	0	0	0	0	0	0	0
CO 5	0	3	0	0	0	0	1	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to power electronics**		**15hrs**	
	1.1	Concepts of power electronics, applications, advantages and disadvantages	3	1
	1.2	Power electronic systems	2	1
	1.3	Power semiconductor devices	2	1
	1.4	Types of power electronic converters	2	1
	1.5	Power electronic modules	2	1
	1.6	Practical- familiarization of various power electronics devices	4	5
2	**Power semiconductor diodes and transistors**		**20hrs**	
	2.1	Characteristics of power diodes, VI characteristics, reverse recovery characteristics	2	2
	2.2	Types of power diodes- general purpose, fast recovery and schottky diodes	2	2
	2.3	Power transistors, BJT, steady state characteristics, switching performance, power MOSFETs, characteristics, comparison of MOSFET with BJT	4	2
	2.4	Insulated gate bipolar transistor, structure and working, characteristics, switching, applications	4	2
	2.5	Practical- 1. Characteristics of TRIAC and DIAC 2. Characteristics of MOSFET	8	5
3	**Thyristors**		**15hrs**	
	3.1	Static VI characteristics, turn on methods, switching characteristics, gate characteristics, thyristor ratings	2	3
	3.2	Thyristor mounting techniques- series and parallel operation	2	3
	3.3	Qualitative ideas of silicon controlled switch	1	3

	3.4	Light activated Thyristors, diac and triac	2	3
	3.5	Practical- Characteristics of Thyristor	8	5
4	**Phase controlled rectifiers and Inverters**		**25hrs**	
	4.1	Principle of phase control, basics of half wave circuits, full wave controlled converters, single phase full wave converters, three phase converter systems using diodes and thyristors, dual convertors	6	4
	4.2	Operating principle of single phase voltage source inverters- three phase bridge inverters- voltage control in single phase inverters	5	4
	4.3	Types of AC voltage controllers- integral cycle control- single phase voltage controller	4	4
	4.4	Practical- Single phase AC controller using TRIAC and Thyristors	10	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15
Assessment methods

Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Bimbhra, P. S. (n.d.). *Power electronics* (Chapters 1, 2, 4, 6, 8, 9). Khanna Publishers.

Suggested Readings

1. Sedha, R. S. (2005). *A textbook of applied electronics*. S. Chand & Co.

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<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Photovoltaic module installation</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDE</td></tr>
<tr><td>Course Code</td><td colspan="5">MG6SDEREM301</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">At the end of this course, the student will be able to design, analyze, and evaluate grid-connected photovoltaic (PV) systems by understanding solar cell technologies, system components, site conditions, and safety requirements.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Apprach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the types, electrical characteristics, and efficiency of solar cells and PV modules, including design options, module components, and quality certifications.	U,An	1,3
2	Analyze the working principles, characteristics, and configurations of grid-connected inverters, and evaluate cabling, connection systems, and switching equipment for PV installations.	An,A	1,2
3	Conduct site surveys and perform detailed shading analysis using diagrams, tools, and software to determine optimal PV-array configurations and minimize shading losses.	A,E	5,4
4	Design and size grid-tied PV systems by selecting suitable modules, inverters, cables, and protection systems considering electrical losses, system architecture, and safety requirements.	E,C	3,5,4
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	3	3	2	0	0	0	0	0	0	0
CO 3	2	2	2	2	3	0	0	0	0	0
CO 4	3	3	3	2	3	0	0	0	0	0
CO 5	0	3	0	0	0	0	1	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Solar Cells and PV modules**	**17 Hrs**	
	1.1	Solar cell types-Equivalent circuit diagrams of solar cells - Spectral sensitivity -Efficiency of solar cells and PV modules.	4	1
	1.2	Types of modules-Design options for PV modules	4	1
	1.3	Module cable outlets and junction boxes -Wiring symbols.	2	1
	1.4	Characteristic I-V curves for modules -Irradiance dependence and temperature characteristic	2	1
	1.5	Hot spots, bypass diodes and shading-Quality certification for modules	2	1
	1.6	Practical :Lux meter and Power meter familiarization.	3	1,3
2		**Inverters, Cables, and Switchgear**	**14 Hrs**	
	2.1	PV array combiner/junction boxes, string diodes and fuses.	1	2
	2.2	Grid-connected inverters -Wiring symbol and method of operation -Grid-controlled inverters -Self-commutated inverters - characteristic curves and properties of grid-connected inverters.	4	2
	2.3	Cabling, wiring and connection systems - Module and string cables -Connection systems -DC main cable -AC connection cable	2	2
	2.4	Direct current load switch (DC main switch) -AC switch disconnector.	1	2
	2.5	Practical :Illuminated I-V characteristics of a solar cell-Calculation of Fill Factor and Efficiency.	6	1,4

3	**Site Surveys and Shading Analysis 18hrs**			
	3.1	Shadow types-Temporary shading. Shading resulting from the location-Shading resulting from the building	3	3
	3.2	Shading analysis-Using a site plan and sun path diagram-Using a sun path diagram on acetate Shade analysis tools using software-Shading,	3	3
	3.3	PV-array configuration and system concept -Connection in series -& in parallel-Comparison of connection concepts	2	3
	3.4	Shading with free-standing/rack-mounted PV arrays - Reducing the mutual shading losses of rack-mounted PV modules	2	3
	3.5	Checklists for building survey	2	3
	3.6	Practical :Study the temperature dependence of open-circuit voltage(V_{oc}) and short-circuit current (I_{sc}) of a solar cell.	6	1,4
4	**Planning and Sizing Grid-Connected Photovoltaic Systems 26 Hrs**			
	4.1	System size and module choice - System concepts.	2	4
	4.2	Central inverter, Sub-array and string, module inverter-Inverter installation site- Sizing the inverter -Choosing the number and power rating of inverters.	3	4
	4.3	Determining the number of strings -Sizing using simulation programs	2	4
	4.4	Selecting and sizing cables for grid tied PV systems -Cable voltage ratings -Cable current carrying capacity -Minimizing the cable losses/voltage drops – Sizing the module and string cabling -Sizing the DC main cableSizing the AC connection cable 171 Selection and sizing of the PV array combiner/junction box and the DC main disconnect/isolator switch. Lightning protection, earthing/grounding and surge protection	4	4
	4.5	Practical :I-V characteristics of a solar cell with different percentage of shading.	15	1,4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Use of CT tools in conjunction with traditional classroom teaching methods. ● Interactive Sessions ● Class Discussions, Lab Exercises

Assessment Types

MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50
Assessment methods: Written Exam
Duration of Examination: 1.5 hrs
Pattern of Examination: Non-MCQ

Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. German Energy Society. (2008). *Planning and installing photovoltaic systems: A guide for installers, architects and engineers* (2nd ed.). Earthscan.
2. Balfour, J. R., & Shaw, M. (2011). *Introduction to photovoltaic system design*. Jones & Bartlett Publishers.

Suggested Readings

1. Solanki, C. S. (2015). *Solar photovoltaics: Fundamentals, technologies and applications* (3rd ed.). PHI Learning.
2. IEEE. (2018). *IEEE standard for interconnection and interoperability of distributed energy resources* (IEEE Std. 1547-2018).

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Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Wind Power Technology				
Type of Course	SDC				
Course Code	MG6SDCREM302				
Course Level	300				
Course Summary	This course introduces the fundamentals of wind energy systems, including the components and operation of wind electric generators and wind pumps. It covers environmental impacts, benefits, and life cycle analysis of wind power				
Semester	6	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the components, working principles, and classifications of wind electric generators including their grid integration and power regulation.	U, Ap	1, 2, 10
2	Analyze the working and limitations of wind pumps including dynamic effects and rotor-pump mismatch characteristics	U, An	1, 2, 3
3	Evaluate the environmental impacts and benefits of wind energy systems, including avian impact, noise, and life cycle emissions.	An, E	2, 6, 7
4	Assess the economic aspects of wind energy projects considering factors such as initial investment, operation costs, payback period, and incentives.	E, Ap	1, 2, 4
5	Demonstrate practical knowledge through hands-on identification, analysis, and layout design of wind turbine systems and environmental assessments.	Ap, C	2, 3, 7
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	3	0	0	0	0	0	0	0	2
CO 2	3	3	2	0	0	0	0	0	0	0
CO 3	0	2	0	0	0	3	3	0	0	0
CO 4	2	3	0	1	0	0	0	0	0	0
CO 5	0	3	3	0	0	0	3	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Wind electric generators** **18 hrs**		
	1.1	Wind electric generator components: Tower, Rotor, Pitch, Gear box, Safety brakes, Nacelle, Yaw, Generator - Induction generator, Synchronous generator, Transformer,	5	1
	1.2	Grid integration, Power regulation, Wind farms - Offshore and Onshore	5	1
	1.3	Practical: Identification and Function of Wind Turbine Components	8	5
2		**Wind pumps** **22 hrs**		
	2.1	Wind powered piston pumps, Limitations of wind driven piston pumps	5	2
	2.2	The hysteresis effect, Mismatch between the rotor and pump characteristics	5	2
	2.3	Dynamic loading of the pump's lift rod, Wind electric pump	4	2
	2.4	Practical : Study of Limitations of Wind-Driven Piston Pumps	8	5
3		**Wind Energy and Environment** **14 hrs**		
	3.1	Environmental benefits of wind energy, Environmental problems of wind energy	2	3
	3.2	Avian issues, Noise emission, Visual impact	2	3
	3.3	Electromagnetic interference, Life cycle analysis - Net energy analysis, Life cycle emission.	3	3
	3.4	Practical : Wind Farm Layout & Environmental Impact Study	7	5
4		**Economics of wind energy** **21 hrs**		
	4.1	Factors influencing the wind energy economics	3	3
	4.2	Site specific factor, Machine parameters, Incentives and exemptions, Energy market;	4	3
	4.3	Cost of wind energy - Initial investment, Operation and maintenance costs, Payback period, Benefit cost ratio.	4	3
	4.4	Practical : Site-Specific Economic Comparison.	10	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Utilize a combination of lectures and hands-on training to facilitate a comprehensive learning experience

Assessment Types

MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50
Assessment methods: Written Exam
Duration of Examination: 1.5 hrs
Pattern of Examination: Non-MCQ

Part	Mark	Instruction
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Sathyajith, M. (2006). *Wind energy: Fundamentals, resource analysis and economics*. Springer.

Additional Reading

1. Johnson, G. L. (2006). *Wind energy systems* (Electronic ed.). Prentice Hall.
2. Burton, T., Sharpe, D., Jenkins, N., & Bossanyi, E. (2001). *Wind energy handbook*. John Wiley.
3. Jha, A. R. (2011). *Wind turbine technology*. CRC Press, Taylor & Francis.
4. Jain, P. (2011). *Wind energy engineering*. McGraw-Hill.

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Kottayam

Faculty/ Discipline	Science				
Programme					
Course Name	Energy Management & Auditing				
Type of Course	MPC				
Course Code	MG6MPCREM300				
Course Level	300				
Course Summary	This course introduces various energy sources, the global and Indian energy scenario, and the link between energy use and economic growth. It covers energy management and the role of Energy Managers under the Energy Conservation Act 2001. It also includes the use of key instruments for measuring electrical, thermal, and fluid parameters in energy audits.				
Semester	6	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		4	0	0	60
Pre-requisites, if any	**Fundamentals of Energy Sources**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concept and importance of energy in modern society.	U,K	3,6,7,10
2	Apply core principles of energy management and auditing.	K,A	4,6,7,10
3	Know the legal role of Energy Managers and how to check and report energy use.	An,S	1,5,6,7
4	Learn to use and understand basic energy audit instruments	U,A,S	1,2,10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }**			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	0	1	0	0	2	2	0	0	1
CO 2	0	0	0	3	0	3	2	0	0	1
CO 3	1	0	0	0	1	2	1	0	0	0
CO 4	1	3	0	0	0	0	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Energy and Policies**		**12 hrs**	
	1.1	Introduction - Types of Energy Sources	2	1
	1.2	World Energy Scenario	2	1
	1.3	Indian Energy Scenario- Energy V/S Economic Growth	4	1
	1.4	Energy Policies, Pricing & Reforms.	4	1
2	**Energy Management & Audit**		**16 hrs**	
	2.1	Energy Management & Audit - Definition and Objective of Energy Management - Principle of Energy Management	2	2
	2.2	Energy Management Skills - Energy Management Strategies	2	2
	2.3	Energy Audit- Types & Methodology- Reporting Format	4	2
	2.4	Understanding Energy Carts - Bench Marking & Energy Performance	4	2
	2.5	Matching Energy to Requirement Maximizing System - Fuel & Energy Substitution.	4	2
3	**Energy Manager-Responsibilities & Duties**		**16 hrs**	
	3.1	Energy Manager-Responsibilities & Duties To Be Assigned Under Energy Conservation Act 2001	3	3
	3.2	Accountability Motivation Of Employees	3	3
	3.3	Requirements For Energy Action Planning – Information System, Marketing & Communicating - Planning &Training	4	3
	3.4	Energy Planning Tools – ENPEP, MARKAL, LEAP, MAED.	4	3
	3.5	Policy Framework for Promotion of Renewable In India – FIP, FIIA	2	3

4	**Energy Audit Instruments**		**16 hrs**	
	4.1	Energy Audit Instruments - Principal And Working of Electrical Measuring Instruments (Voltmeter, Ammeter ,Power Factor Meter)	4	4
	4.2	Flue Gas Analyzer , Temperature Measurement- Contact Type Methods, Non-Contact Type Methods	4	4
	4.3	Pressure And Velocity Measurement (Bourdon Gauge, Manometers, Anemometer)	4	4
	4.4	Flow Measurement Of Steam, Water And Air -Humidity Measurement And Leak Detectors	4	4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70
Assessment methods: Written Exam
Duration of Examination: 2 hrs
Pattern of Examination: Non-MCQ

Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Turner, W. C. (2001). *Energy management handbook*. Fairmont Press.
2. Bureau of Energy Efficiency. (n.d.). *General aspects of energy management & energy audit*.

Suggested Readings

1. Kothari, D. P., Singal, K. C., & Ranjan, R. (n.d.). *Renewable energy sources and emerging technologies*. PHI Learning Pvt. Ltd.
2. Bureau of Energy Efficiency. (n.d.). *BEE India*. https://www.beeindia.gov.in
3. Energy Community. (n.d.). *LEAP*. https://www.energycommunity.org

Mahatma Gandhi University Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Renewable energy policies and business models</td></tr>
<tr><td>Type of Course</td><td colspan="5">SEC</td></tr>
<tr><td>Course Code</td><td colspan="5">MG6SECREM300</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive understanding of renewable energy policies, covering global and Indian frameworks, key legislation, and institutional structures. It explores regulatory instruments, incentives, and mechanisms supporting renewable energy adoption, along with diverse business models and financing strategies. Case studies and local policy analysis deepen students' insights into practical applications and challenges in the renewable energy sector.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">NIL</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the evolution of global and Indian renewable energy policies and evaluate the role of national and international policy frameworks in promoting sustainable energy development.	U,E	1,2,7,10
2	Analyze key regulatory mechanisms and incentives supporting renewable energy deployment in India, with emphasis on case studies from various states.	A,An,I	1,2,3,6,7
3	Examine different business models and financing options for renewable energy projects and assess their effectiveness through real-world examples.	A,An,E	1,2,3,5,9
4	Critically review Kerala's renewable energy policy and enhance policy literacy through expert interactions and research-based presentations.	E,C,Ap	1,4,6,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	2	0	0	2
CO 2	3	3	3	0	0	2	2	0	0	1
CO 3	3	3	3	0	2	0	0	0	2	1
CO 4	3	0	0	2	0	2	0	0	2	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Renewable Energy Policy Frameworks 15 hrs**		
	1.1	Evolution of renewable energy policies – global overview (EU, US, China)	3	1
	1.2	India's renewable energy development milestones, National policies: Electricity Act 2003, National Electricity Policy, NAPCC, Institutional framework: MNRE, IREDA, SECI, State Nodal Agencies	7	1
	1.3	International climate agreements: UNFCCC, Kyoto Protocol, Paris Agreement, State Action Plans on Climate Change (SAPCC), INDCs	5	1
2		**Regulatory Instruments and Policy Mechanisms 15 hrs**		
	2.1	Renewable Purchase Obligations (RPOs), Renewable Energy Certificates (RECs), Feed-in Tariff vs Competitive Bidding Mechanism	4	2
	2.2	Net Metering and Gross Metering, Policy support for rooftop solar, EV policies, FAME scheme, Incentives: Capital Subsidies, Accelerated Depreciation, Generation-based Incentives	6	2
	2.3	Case studies: Tamil Nadu, Gujarat, and Kerala policy analysis	5	2
3		**Business Models and Financing Mechanisms 15 hrs**		
	3.1	Business Models: BOO, BOOT, IPP, ESCO, Community-based,PPP Models in RE	5	3
	3.2	Corporate Power Purchase Agreements (PPAs), Peer-to-Peer trading, Sources of finance: Equity, Debt, Green Bonds	5	3
	3.3	CSR,Multilateral financing: World Bank, ADB, Green Climate Fund, Case studies: Solar parks, mini-grids, distributed solar in Kerala	5	3
5	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table>
B. End Semester Evaluation (ESE)
Theory
<table>
<tr><td colspan="3">Total mark: 50</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 10 out of 12</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 4 out of 6</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table>
Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

1. Ministry of New and Renewable Energy. (n.d.). *Policy guidelines and white papers*.
2. Mallon, K. (n.d.). *Renewable energy policy and politics*.
3. International Renewable Energy Agency, & International Energy Agency. (n.d.). *Reports*.
4. The Energy and Resources Institute. (n.d.). *Energy & environment yearbook*.
5. Organisation for Economic Co-operation and Development, & International Renewable Energy Agency. (n.d.). *Reports on business models*.
6. World Bank, & Asian Development Bank. (n.d.). *Publications on renewable energy finance*.

Mahatma Gandhi University Kottayam

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Energy Conservation Techniques				
Type of Course	VAC				
Course Code	MG6VACREM300				
Course Level	300				
Course Summary	This course provides foundational knowledge of energy conservation, including legislation, audit and management techniques, and practical methods for conserving energy in electrical, thermal, and building systems..				
Semester	6	**Credits**		3	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	0	0	45 hours
Pre-requisites, if any	**NIL**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the importance of energy conservation and methods of waste minimization.	U, An	1, 2, 6, 10
2	Analyze and apply energy management principles and audit techniques using appropriate instruments and methodologies.	An, A, S	2, 3,5
3	Identify and evaluate energy conservation opportunities in electrical and thermal systems	An	1, 2, 7, 10
4	Recommend and implement energy-efficient solutions for residential and commercial buildings.	C, A	1, 3, 8
**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	2	0	0	0	1
CO 2	0	3	3	0	3	0	0	0	0	0
CO 3	2	2	0	0	0	0	2	0	0	2
CO 4	2	0	3	0	0	0	0	2	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Energy Conservation**		**8hrs**	
	1.1	Introduction Energy conservation & its importance - The Energy Conservation Act 2001 & its features	2	1
	1.2	Waste Minimization & Resource Conservation -Need of waste minimization - Waste minimization method & its classification	4	1
	1.3	Effects of waste environment & Role of pollution control board - Case study.	2	1
2	**Energy Audit and Instrument**		**20hrs**	
	2.1	Energy Management & Audit - Definition and Objective of Energy Management - Principle of Energy Management - Energy Management skills	3	2
	2.2	Energy Manager-Responsibilities & Duties To Be Assigned Under Energy Conservation Act 2001	3	2
	2.3	Energy Audit -Types & Methodology - Energy Audit Reporting format	3	2
	2.4	Energy Audit Instruments- Principal And Working of Electrical Measuring Instruments (Voltmeter, Ammeter ,Power Factor Meter)	4	2
	2.5	Flue Gas Analyzer , Temperature Measurement- Contact Type Methods, Non-Contact Type Methods)	5	2
	2.6	Pressure And Velocity Measurement (Bourdon Gauge, Manometers, Anemometer	2	2

3	**Energy Conservation Methods in Electrical and Thermal System 17hrs**			
	3.1	Motors - Power factor improvement techniques	3	3
	3.2	Effects of harmonics - Star-Delta conversion techniques - Variable speed drive (VSD)	5	3
	3.3	Energy conservation in electric furnaces, Pumps, Compressors, Fans, Blowers ,Lighting systems	3	3
	3.4	Energy conservation in HVAC systems .Boiler & furnace - Steam distribution system – Waste heat recovery	4	3
	3.5	Energy Conservation in Housing & Commercial Building in Lighting System	2	4
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 50
Assessment methods: Written Exam
Duration of Examination: 1.5 hrs

Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 10 out of 12
Part B	5 mark	Answer any 4 out of 6
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Awasthi, S. K. (1989). *Energy conservation in the chemical & allied industries*. South Asian Publishers.
2. Turner, W. C. (2001). *Energy management handbook*. Fairmont Press.

Suggested Reading

1. Chiogioji, M. H. (1979). *Industrial energy conservation*. M. Dekker.

Mahatma Gandhi University
Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Project</td></tr>
<tr><td>Type of Course</td><td colspan="5">PRJ</td></tr>
<tr><td>Course Code</td><td colspan="5">MG6PRJREM300</td></tr>
<tr><td>Course Level</td><td colspan="5">300</td></tr>
<tr><td>Course Summary</td><td colspan="5">The Project Work course is designed to enable students to apply theoretical knowledge and practical skills acquired throughout the B.Voc in Renewable Energy Management program to real-world problems. Students undertake individual or group projects in collaboration with industry, research institutions, or academic supervisors to explore a specific problem, design a solution, or conduct a study related to renewable energy technologies, energy efficiency, or sustainable energy systems.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>2</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practical</td><td>OJT*</td></tr>
<tr><td>0</td><td>4</td><td>0</td><td>20+8 days</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply theoretical knowledge to analyze and solve real-world problems through the execution of domain-specific projects.	An,E	1, 2
2	Demonstrate the ability to design and implement project solutions using appropriate tools, technologies, and methodologies relevant to their field.	E,C	8
3	Collaborate effectively in teams or work independently to manage project tasks, timelines, and deliverables in a professional setting.	C, S	2, 7, 10
4	Communicate project outcomes clearly through technical documentation and presentations, while reflecting on professional and ethical responsibilities.	E	4, 9

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	3	0	0
CO 3	0	2	0	0	0	0	2	0	0	3
CO 4	0	0	0	2	0	0	0	0	1	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Total mark: 30	
Type of assessment	
Commitment and Involvement	5
Periodic progress review	10
Report	15

B. End Semester Evaluation (ESE)

Total mark: 70	
Type of assessment	
Relevance of the topic	10
Review of literature	10
Implementation/ Results	10
Presentation	20
Viva Voce	20

SEMESTER 7& 8 (APPRENTICESHIP)

विद्यया अमृतमश्नुते	**Mahatma Gandhi University Kottayam**

Faculty/ Discipline	Science				
Programme	B.Voc . (Honours) Renewable Energy Management				
Course Name	Apprenticeship				
Type of Course	APP				
Course Code	MG7APPREM400				
Course Level	**400**				
Course Summary	The **Apprenticeship** course in the B.Voc Renewable Energy Management program provides students with structured, hands-on experience in the renewable energy sector through direct engagement with industries, government agencies, or energy enterprises. This industry-integrated training aims to enhance the practical knowledge and employability of students by exposing them to real-time work environments, tools, technologies, and practices in renewable energy systems and services.				
Semester	7 & 8	**Credits**		28	**Total Hours**
Course Details	**Learning Approach**	**Lecture***	**Practical**	**OJT***	
		0	28	0	280 days
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall key national and international policies, standards, and procedures relevant to renewable energy project execution.	K	1, 2
2	Demonstrate a sound understanding of workplace safety protocols, industry regulations, and project documentation standards.	U	2, 7
3	Apply advanced theoretical and practical knowledge in renewable energy technologies during live industrial projects and site work.	A	1, 2, 3, 10
4	Analyze and troubleshoot performance issues in existing renewable energy systems and suggest effective solutions.	An	2, 3, 5
5	Evaluate the techno-economic feasibility of renewable energy projects using appropriate tools and standards.	E	7, 10
6	Design and implement small-scale renewable energy systems independently or as part of a project team.	S, C	2, 3, 5, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	0	0	0	0	0
CO 2	0	3	0	0	0	0	3	0	0	0
CO 3	1	2	2	0	0	0	0	0	0	2
CO 4	0	3	2	0	2	0	0	0	0	0
CO 5	0	0	0	0	0	0	2	0	0	1
CO 6	0	2	1	0	2	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT
	A. Continuous Comprehensive Assessment (CCA)

Total mark: 90	
Type of assessment	
Commitment, Punctuality & Professional conduct	20
Monthly progress reviews & Logbook maintenance	25
Skill development and Application	25
Interim Report	20

B. End Semester Evaluation (ESE)

Total mark: 210	
Type of assessment	
Feedback & Evaluation report from Host organization	50
Skill demonstration/ Summary of work exposure	40
Final report/ Learning portfolio	40
Domain knowledge and experience communication (Presentation)	40
Viva voce	40

Note:
This assessment framework is intended as a guiding structure for evaluation of apprenticeship performance. However, in order to remain responsive to the evolving needs of industry and society, the evaluation criteria may be revised from time to time. Such changes aim to enhance the relevance, effectiveness and fairness of the assessment process.

SEMESTER 7 & 8
(RESEARCH INTERNSHIP)

Mahatma Gandhi University Kottayam

<table>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc . (Honours) Renewable Energy Management</td></tr>
<tr><td>Course Name</td><td colspan="5">Research Internship</td></tr>
<tr><td>Type of Course</td><td colspan="5">RIN</td></tr>
<tr><td>Course Code</td><td colspan="5">MG7RINREM400</td></tr>
<tr><td>Course Level</td><td colspan="5">400</td></tr>
<tr><td>Course Summary</td><td colspan="5">The Research Internship in the B.Voc Renewable Energy Management program is designed to introduce students to research methodologies and practices in the renewable energy sector. This course provides an opportunity for students to engage in supervised research activities, either in academic institutions, government agencies, or renewable energy industries.</td></tr>
<tr><td>Semester</td><td>7 &8</td><td colspan="2">Credits</td><td>20</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practical</td><td>OJT*</td></tr>
<tr><td>0</td><td>20</td><td>0</td><td>200 days</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the research process, including problem identification, literature review, and methodology formulation.	U	1, 2
2	Apply theoretical concepts to investigate a defined research problem in the renewable energy domain.	A	2, 3, 6, 10
3	Analyze experimental or simulation data using appropriate scientific or engineering tools.	An	2
4	Critically evaluate existing technologies or systems and propose data-driven improvements or alternatives.	E	2, 6
5	Design and develop experimental setups, small-scale prototypes, or simulation models relevant to the chosen research topic.	C	3, 5, 10
6	Document research findings in the form of a technical report or research paper and present it effectively.	I	5, 9, 10
7	Identify new or unexplored opportunities for innovation or process improvement in renewable energy technologies.	C, S, Ap	1, 2, 5, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	1	0	0	0	0	0	0	0	0
CO 2	0	2	2	0	0	1	0	0	0	1
CO 3	0	3	0	0	0	0	0	0	0	0
CO 4	0	2	0	0	0	2	0	0	0	0
CO 5	0	0	2	0	0	2	0	0	0	1
CO 6	0	0	0	0	3	0	0	0	2	1
CO 7	2	1	0	0	2	0	0	0	0	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)

Total mark: 90	
Type of assessment	
Commitment, Punctuality & Professional conduct	20
Monthly progress reviews & Logbook maintenance	25
Skill development and Application	25
Interim Report	20

B. End Semester Evaluation (ESE)

Total mark: 210	
Type of assessment	
Feedback & Evaluation report from Host organization	50
Skill demonstration/ Summary of work exposure	40
Final report/ Learning portfolio	40
Domain knowledge and experience communication (Presentation)	40
Viva voce	40

Note:
This assessment framework is intended as a guiding structure for evaluation of apprenticeship performance. However, in order to remain responsive to the evolving needs of industry and society, the evaluation criteria may be revised from time to time. Such changes aim to enhance the relevance, effectiveness and fairness of the assessment process.

Syllabus Revision Workshop Participants

1. Sruthi Soman - Assistant Professor, Sree Sankara College, Kalady
2. Abhirami Sunil - Assistant Professor, Sree Sankara College, Kalady
3. Amrutha P N - Assistant Professor, Sree Sankara College, Kalady
4. Dr.Anugop B - Assistant Professor, St.Alberts (Autonomous) Ernakulam